JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOLUME 40 April 15, 1950 No. 4

PHYSICS.—*Note on the specific heat of liquid-vapor mixtures.*[1] L. GOLDSTEIN, Los Alamos Scientific Laboratory of the University of California, Los Alamos, N. Mex. (Communicated by F. G. BRICKWEDDE.)

In this paper it is shown that the experimental determination of the constant volume specific heat discontinuity in crossing the vapor or liquid saturation line of a fluid provides a direct verification of one group of Ehrenfest type of thermodynamic relations.

Consider the diagram of state of an ordinary fluid in the pressure-volume plane. One can easily evaluate the specific heat at constant volume of the fluid in a state represented by a point (p, v) on the isothermal T in the region of the liquid and vapor mixture. Let us limit ourselves first to the region $T < T_c$, $p < p_c$, $v > v_c$, the subscript c referring to the values of these coordinates at the critical point. Let x be the quality of the mixture. Then, the absorption of an amount of heat dQ by the unit mass of the mixture leads to the transformation,

$$dQ = L\,dx + [c_{sl}(1 - x) + c_{sv}x]\,dT, \quad (1)$$

where L is the latent heat of vaporization at temperature T, c_{sl} and c_{sv} are the specific heats of the liquid and vapor phases along their respective branches of the saturation curve at the same temperature T. The volume of the unit mass of the mixture is defined by

$$v = u_l(1 - x) + u_v x, \quad (2)$$

u_l and u_v denoting the volumes of the unit mass of the saturated liquid and saturated vapor. With

$$c_{sl} - c_{sv} = \frac{dL}{dT} - \frac{L}{T}, \quad (3)$$

one obtains,

$$\left(\frac{dQ}{dT}\right)_v = c_v = c_{sl} - \frac{Lx}{T} + \frac{d(Lx)}{dT}, \quad (4)$$

for the constant volume specific heat of the mixture in the state (p, v, T).

The preceding expression describes the variation of this specific heat along a $v =$ Constant line in the (p, v) plane. We have computed this specific heat for water along the

$$v = v(100° \text{ C.}), \quad v = v(120° \text{ C.}), \quad \text{and } v = v(140° \text{ C.})$$

lines, respectively, in the mixture region and completed the calculation by noting the experimental values of the constant volume specific heat of the vapor in crossing the saturation line.

The results of these calculations are given in Fig. 1.

The high specific heat of the mixture is due to the evaporation taking place in the transformations along the constant volume lines. The values of the discontinuities are defined by

$$\Delta c_v = c_{v+} - c_{v-}, \quad (5)$$

c_{v+} and c_{v-} being the constant volume specific heats of the high and low temperature "phases" at the transition points. Of these, the low temperature phase is the liquid and vapor mixture, while the high temperature phase is the pure vapor phase or liquid phase, depending on whether one follows a constant volume line, in the (p, v) plane, at $v > v_c$ or $v < v_c$, respectively.

A general expression can now be derived for c_v, without difficulty. Since, according to the Clapeyron equation,

[1] Received January 5, 1950.

$$L = T\frac{dp}{dT}(u_v - u_1), \tag{6}$$

and, from equation (2), along a constant volume line,

$$dv = (1-x)\,du_1 + x\,du_v + dx(u_v - u_1) = 0, \tag{7}$$

one finds,

$$dx = -\frac{1}{(u_v - u_1)}[(1-x)\,du_1 + x\,du_v]. \tag{8}$$

Substituting (6) and (8) into equation (1), one obtains:

$$\left(\frac{dQ}{dT}\right)_v = c_v = (1-x)\left[c_{s1} - T\frac{dp}{dT}\frac{du_1}{dT}\right] + x\left[c_{sv} - T\frac{dp}{dT}\frac{du_v}{dT}\right]. \tag{9}$$

At the vapor saturation curve, $x \to 1$, and

$$c_{v-} = \lim_{x\to 1} c_v = c_{sv} - T\frac{dp}{dT}\frac{du_v}{dT}, \tag{10}$$

while the constant volume specific heat of the saturated vapor, which is that of the phase beyond or in the vicinity of the saturation curve, is, according to thermodynamics,

$$c_{v+} = c_{sv} - T\left(\frac{\partial p}{\partial T}\right)_{u_v}\frac{du_v}{dT}, \tag{11}$$

where $\left(\frac{\partial p}{\partial T}\right)_{u_v}$ is to be computed from the equation of state of the saturated vapor. Hence, from (10) and (11),

$$\Delta c_v = c_{v+} - c_{v-} = -T\left(\frac{du_v}{dT}\right)\left[\left(\frac{\partial p}{\partial T}\right)_{u_v} - \frac{dp}{dT}\right] = -T\left(\frac{du_v}{dT}\right)\Delta\left(\frac{\partial p}{\partial T}\right)_v, \tag{12}$$

where, we write

$$\Delta\left(\frac{\partial p}{\partial T}\right)_v = \left(\frac{\partial p}{\partial T}\right)_{v+} - \left(\frac{\partial p}{\partial T}\right)_{v-} = \left(\frac{\partial p}{\partial T}\right)_{u_v} - \frac{dp}{dT}, \tag{13}$$

since in the mixed phase region,

$$\left(\frac{\partial p}{\partial T}\right)_{v-} = \frac{dp}{dT},$$

the temperature coefficient of the pressure is equal to the slope of the vapor pressure curve. Equation (12) is often called the Ehrenfest formula expressing the discontinuity of the constant volume specific heat Δc_v across a transition line.

As long as v is large in comparison with v_c, one may use, approximately, the perfect gas law for the equation of state of the saturated vapor. One has, then, approximately,

$$\underset{v>v_c}{\Delta c_v} = c_{v,\text{vap.}} - \lim_{x\to 1} c_{v,\text{mix.}} = T\left(\frac{du_v}{dT}\right)\left[\frac{dp}{dT} - \frac{p}{T}\right]. \tag{14}$$

The knowledge of the temperature variation of the vapor specific volume, i.e., $\left(\frac{du_v}{dT}\right)$ and the vapor pressure curve of the substance under consideration, allows one to evaluate the constant volume specific heat jump Δc_v.

Formula (12) leads at once to the following general conclusion concerning the sign of the discontinuity Δc_v at volumes larger than the critical volume. Along the vapor saturation curve, one has necessarily

$$\frac{du_v}{dT} < 0, \qquad u_v > v_c;$$

on the other hand,

$$\left(\frac{\partial p}{\partial T}\right)_{u_v} < \frac{dp}{dT};$$

hence,

$$\underset{v>v_c}{\Delta c_v} < 0, \tag{15}$$

along the vapor saturation curve. The constant volume specific heats of normal fluids undergo a lambda point type of discontinuity at the crossing of the vapor saturation curve.

We should like to consider now the transition across the liquid saturation curve, or the constant volume specific heat changes along constant volume lines $v < v_c$. One finds here

$$\underset{v<v_c}{\Delta c_v} = c_{v+} - c_{v-} = c_{v+} - \lim_{x\to 0} c_{v,\text{mix.}}, \tag{16}$$

where, the constant volume specific heat of the saturated liquid is

$$c_{v+} = c_{sl} - T\left(\frac{\partial p}{\partial T}\right)_{u_1}\left(\frac{du_1}{dT}\right), \tag{17}$$

the partial derivative $\left(\frac{\partial p}{\partial T}\right)_{u_1}$ being derived from the equation of state of the liquid. Also,

$$\lim_{x\to 0} c_{v,\text{mix.}} = c_{vl} = c_{sl} - T\left(\frac{dp}{dT}\right)\left(\frac{du_1}{dT}\right). \tag{18}$$

Hence,

$$\underset{v<v_c}{\Delta c_v} = T\left(\frac{du_1}{dT}\right)\Delta\left(\frac{\partial p}{\partial T}\right)_v = T\left(\frac{du_1}{dT}\right)\left[\frac{dp}{dT} - \left(\frac{\partial p}{\partial T}\right)_{u_1}\right]. \tag{19}$$

Now, the temperature coefficient of the specific volume of the saturated liquid is positive,

$$\frac{du_1}{dT} > 0,$$

while the partial derivative $\left(\frac{\partial p}{\partial T}\right)_{u_1}$ of the saturated liquid is always such that

$$\left(\frac{\partial p}{\partial T}\right)_{u_1} > \frac{dp}{dT}, \qquad u_1 < v_c.$$

As a result,

$$\underset{v<v_c}{\Delta c_v} < 0, \tag{20}$$

or the discontinuity is again negative in crossing from the mixture region into the pure liquid phase region. However, there is a considerable difference in the numerical values of the Δc_v's at the same temperature. One finds that

$$|\underset{v>v_c}{\Delta c_v}(T)| > |\underset{v<v_c}{\Delta c_v}(T)|. \tag{21}$$

Since

$$\left(\frac{\partial p}{\partial T}\right)_{u_1} = \frac{1}{u_1}\left(\frac{\partial u_1}{\partial T}\right)_p\left[-u_1\left(\frac{\partial p}{\partial v}\right)_T\right] = \frac{\alpha_s}{\chi_{T,s}}$$

where α_s and $\chi_{T,s}$ are respectively the volume expansion coefficient and the isothermal compressibility of the saturated liquid, which quantities are likely to be well approximated by the bulk liquid values at the pressure

TABLE 1.—VERIFICATION OF THE EHRENFEST RELATIONS (WATER) ACROSS THE VAPOR SATURATION LINE[1]

(1) $$\underset{v>v_c}{\Delta} c_v = T\left(\frac{dV}{dT}\right)^2\Delta\left(\frac{\partial p}{\partial v}\right)_T = -T\left(\frac{dV}{dT}\right)\Delta\left(\frac{\partial p}{\partial T}\right)_v$$

(2) $$\underset{v>v_c}{\Delta}\left(\frac{\partial p}{\partial T}\right)_v = -\left(\frac{dV}{dT}\right)\Delta\left(\frac{\partial p}{\partial V}\right)_T$$

$T°$ C.	100	120	140	160	180
$-\Delta c_v$ cal/gm. degree	16.36	14.11	12.11	10.70	8.95
$-T\left(\frac{dV}{dT}\right)^2\Delta\left(\frac{\partial p}{\partial V}\right)_T$ cal/gm. degree	16.64	14.06	12.76	11.26	9.57
$-\underset{v>v_c}{\Delta}\left(\frac{\partial p}{\partial T}\right)_v$ mm Hg/degree	25.13	43.31	69.64	106.8	155.9
$\left(\frac{dV}{dT}\right)\Delta\left(\frac{\partial p}{\partial V}\right)_T$ mm Hg/degree	25.24	43.97	72.08	111.1	164.0

The increasing deviations at the higher temperatures are probably due to the ideal gas approximation of the saturated vapor equation of state and the use of ordinary liquid thermal properties instead of those of the saturated liquid.

[1] Most of the data used here were taken from the Landolt-Bornstein tables and from the book by N. E. Dorsey, *Properties of ordinary water substance*, Reinhold Publishing Corporation, New York (1940).

and temperature in question, the discontinuity (18) becomes

$$\underset{v<v_c}{\Delta c_v} = T\left(\frac{du_1}{dT}\right)\left[\frac{dp}{dT} - \frac{\alpha}{\chi_T}\right]. \quad (22)$$

Beside the specific heat discontinuities, one obtains, by expressing the absence of discontinuities of pressure across the transition line,

$$\underset{v>v_c}{\Delta}\left(\frac{\partial p}{\partial T}\right)_v = -\frac{du_v}{dT}\Delta\left(\frac{\partial p}{\partial V}\right)_T. \quad (23)$$

Here

$$\Delta\left(\frac{\partial p}{\partial V}\right)_T = \left(\frac{\partial p}{\partial V}\right)_{\text{vap.}} - \left(\frac{\partial p}{\partial V}\right)_{\text{mix.}}$$

$$= \left(\frac{\partial p}{\partial V}\right)_{\text{vap.}},$$

since for the mixture the vapor pressure is independent of the volume. The left side of (23) is given by equation (13), so that again a full verification of equation (23) can be obtained. At temperatures T far enough from the critical temperature $\left(\frac{\partial p}{\partial V}\right)_{\text{vap}}$ may be taken to be the ideal gas value.

Equations (14) and (23) have been verified, by the writer, for water at a number of temperatures extending from 100°C. to 180°C. It appears then that the different types of discontinuities associated with the transition across the saturation lines corre-

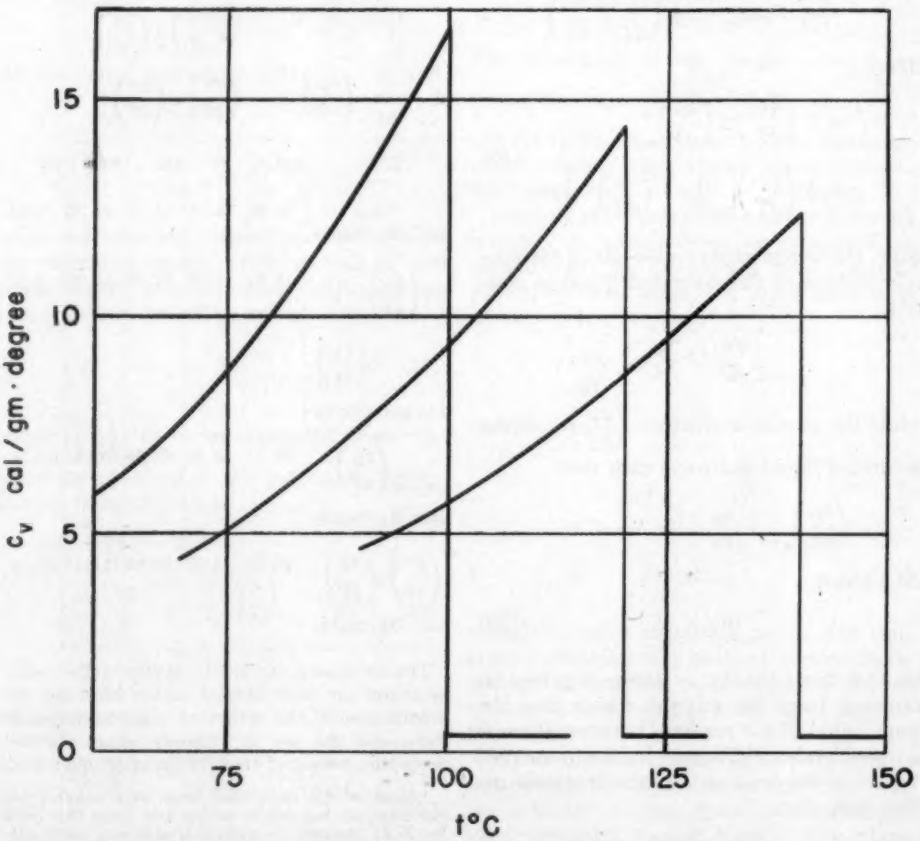


FIG. 1.—Constant volume specific heat of water vs. temperature (°C.), along constant volume lines in the liquid-vapor mixed phase and across the vapor saturation line.

spond to those expressed by Δc_v or $\Delta \left(\frac{\partial p}{\partial V}\right)_T$ and provide an interesting check of the so-called Ehrenfest type formulae.[2]

Very recently we had the opportunity of learning, through the courtesy of Dr. F. G. Brickwedde, of preliminary measurements of constant volume specific heats of liquid-vapor mixtures of oxygen, performed by Dr. H. J. Hoge at the National Bureau of Standards. These as yet unpublished data, kindly put at our disposal by Dr. Hoge, tend to confirm the expected behavior of the constant volume specific heat of liquid-vapor mixtures and are similar to those derived for water and given in Fig. 1.

[2] The behavior of normal fluids in the liquid-vapor mixed phase region and the thermodynamic relations governing the discontinuities of the constant volume specific heat at the crossing of the saturation curve have been shortly mentioned in a previous paper, cf. L. Goldstein, Journ. Chem. Phys. **14**: 276. 1946.

ARCHEOLOGY.—*An archeological survey of the Chattahoochee River Valley in Florida.*[1] RIPLEY P. BULLEN, Florida Board of Parks and Historic Memorials. (Communicated by GORDON R. WILLEY.)

Construction of the Jim Woodruff Dam on the Apalachicola River, south of the confluence of the Chattahoochee and Flint Rivers, will form a large lake covering 37,500 acres of Alabama, Florida, and Georgia. Realizing that much data pertaining to the prehistory of Florida would otherwise be lost, the Florida Park Service instigated an archeological survey of the west side of the Chattahoochee River to include the 8,500 acres of Florida to be inundated. Except for one mound excavated by Moore in 1903, this territory was archeologically unknown.

Field work was done during October and November 1948 under the general supervision of John W. Griffin, archeologist of the Florida Board of Parks and Historic Memorials. Dr. Raymond F. Bellamy, of the Florida State University, twice spent several days helping with the field work. Dr. John M. Goggin, of the University of Florida, aided in the identification of types of pottery. The survey is also indebted to Dr. A. R. Kelly, of the University of Georgia, and William H. Sears, of the University of Michigan, for an introduction to pottery types of southwest Georgia; to Dr. Frank H. H. Roberts, Jr., of the Smithsonian Institution, for the procurement of necessary maps; to Dr. Gordon R. Willey, also of the Smithsonian Institution, for manuscript sheets covering pottery descriptions from his forthcoming publication; and to Wesley R. Hurt, of the University of Michigan, for a copy of a preliminary report on his survey of the middle Chattahoochee River Valley in Alabama. O. W. Tidwell, resident engineer of the Jim Woodruff Dam project; Dr. J. H. Therrell, superintendent; Col. Charles V. Imeson, engineer; and Paul Bemis, farm manager, of the Florida State Hospital, were most cooperative. All land owners freely gave permission to work on their land.

A contour map of the area covered by the survey, showing site locations, is presented as Fig. 1.[2] The survey was limited to land below the 80-foot contour—77 feet being the elevation of water to be impounded by the Jim Woodruff Dam—and to higher land immediately adjacent thereto. For practical purposes that meant the land between a road, which runs northward from Sneads, and the Chattahoochee Fiver (Fig. 1). Many private field, wood, and logging roads extend eastward from this road toward the river. Transportation was by car as far as possible, then on foot carrying tools, maps, notes, etc.

Plowed fields and old cultivated areas were walked over and tested by means of small holes to see if Indian material was present below the plowed zone. Places where erosion had occurred were examined. In the bottomland, where no evidence of occupation could be found on the surface, innumerable holes were dug at places of

[1] Received January 9, 1950.

[2] Reduced from topographic survey sheets kindly supplied by the U. S. Engineers Office, Mobile, Ala.

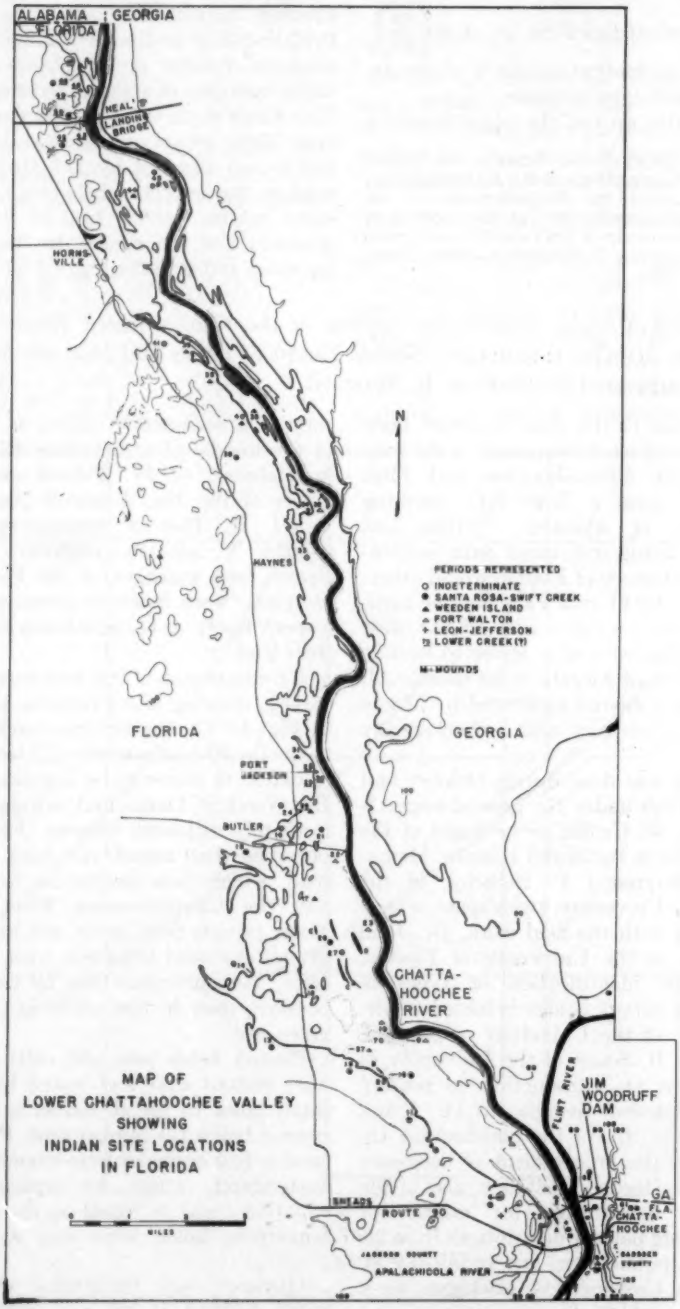


FIG. 1.—Map of Lower Chattahoochee River, showing location of Indian sites.

slightly higher elevation which might have been occupied. Along the recent natural levee these holes had to be as deep as three or four feet to uncover Indian remains. Face of the levee was frequently examined for occupational zones. At buried sites several test squares were excavated to secure an adequate sample, check stratigraphy, and record profiles.

The map (Fig. 1) indicates few sites southeast of Hayes and east of Hornesville. These areas were heavily wooded, which no doubt explains the failure to locate sites above the 80-foot contour. The present natural levee along this portion of the Chattahoochee was carefully tested with negative results except for site 32.

Fifty-four Indian sites were investigated during the survey. These are located on the map (Fig. 1), and their allocation to various archeological periods is indicated by symbols (explained on the map). Geographical factors appear to have affected the location of Indian sites in the lower Chattahoochee Valley during certain archeological periods. This is mentioned here so that the reader may, if he wishes, examine the map and anticipate certain conclusions while reading the sections on geographical background and summary of sites.

Allocation of sites to archeological periods was based on their ceramic inventory and follows the chronological scheme presented by Willey and Woodbury (1942) for the northwest Florida coast. To this ceramic sequence of Deptford, Santa Rosa-Swift Creek, Weeden Island I, Weeden Island II, and Fort Walton has been added the Leon-Jefferson Spanish mission period defined by Smith (1948) and, tentatively, for the lower Chattahoochee Valley, a later Lower Creek (?) period. Ceramic typology follows Willey's recent definitions (1945, 1948, 1949). Types for the Leon-Jefferson priod have been defined by Smith (1948), Alachua Cob Marked by Goggin (1948a), and Pinellas Incised B by Griffin (MS.). Chattahoochee Brushed is defined below.

TYPE: CHATTAHOOCHEE BRUSHED

Definition as a type: Defined here on basis of 203 sherds found in lower Chattahoochee Valley. See Figs. 10, *e*; 11, *b-d*.

Paste:

Method of manufacture: By some annular method of vessel building.

Temper: Sand and medium coarse grit rather abundant.

Texture: Coarse, lumpy, and contorted.

Hardness: 3.5

Thickness: 5–8 mm.

Color: Cores are white, light gray, or black. Surfaces are white, whitish-blue, and light gray, sometimes tan.

Surface finish and decoration: Interiors are well smoothed. Some smoothing of exteriors before brushing. Temper particles protrude on both surfaces. Exteriors brushed or scored, producing fine lines which vary from 0.2 to 1 mm in width. While irregularly applied, lines tend to parallel each other. Brushing may be limited to upper part of vessels as plain sherds, otherwise the same, were found.

Filming: Vessels probably received a clay wash.

Form:

Shape: Unknown.

Rims: The three available are slightly thickened and two of them chamfered at outer lip.

Geographical range of type: Fairly abundant in lower and middle (Hurt, MS.) Chattahoochee Valley and in southwestern Georgia.[3] Four sherds were found at Lake Jackson, a Fort Walton site near Tallahassee (Griffin, MS.). One sherd is known for the Gainesville area.[4]

Chronological position of type: By seriation this type is post-Fort Walton.

Relationship of type: Related to Alachua Cob Marked of central Florida and Walnut Roughened of western Georgia.

Sherds, which might have been classified as "Chattahoochee Plain," have been included in site analyses under "Plain, Ft. Walton paste." When the whitish surface color, typical of Chattahoochee Brushed and believed to be the result of a wash, was definitely present, the quantity so affected has been indicated by numbers in parentheses. A similar notation has been used in the case of other types when this color was present.

[3] Dr. A. R. Kelly, University of Georgia, personal communication.

[4] Collections of the University of Florida, Anthropological laboratory.

Quantities so indicated are minimum as standards were very rigid in respect to this surface condition.

GEOGRAPHICAL BACKGROUND

The lower Chattahoochee River extends 25 miles from its confluence with the Flint north-northwest to the Alabama state line. The 50-foot contour crosses the river about half a mile north of Port Jackson, while the 60-foot contour crosses about a quarter of a mile north of the Alabama line. The gradient of the river is, therefore, 10 feet in 15½ miles. The Chattahoochee carries a heavy burden of clay and sand. The waters of the Flint, by comparison, are much clearer of debris.

The lower Chattahoochee Valley is divided into two zones—bottomlands and uplands. Except at Butler, where the 70-foot contour reaches the river, the 80-foot contour divides these two zones. The 90-foot contour follows the 80-foot fairly closely. In times of flood much of the valley may be under water. High-water mark for the 1929 flood was 89.6 feet north of Sneads and 99.3 feet at Neals Landing Bridge.

Various limestone formations underlie the whole area. These outcrop to the north and east of Sneads, where the 70-, 80-, and 90-foot contours are essentially one. Limestone outcrops again at the Alabama line. Decayed limestone is sometimes found in plowed fields and at other places between these points. These limestones contain chert, which was used by Indians as material out of which to fashion projectile points and other tools. Unless otherwise specified all chips and stone tools mentioned in this paper are made of such chert.

Soil on the uplands consists of coarse sandy loam resting on red clay. This sandy deposit varies considerably in thickness. In places it has eroded entirely away. Over much of the area it forms a thin mantle about 6 inches thick. At site J-3, west of the dam, it is over 2 feet thick. In a few places a good loam has formed, but in general this is not good farmland.

Most of the bottomland is covered with compact clay-silt, which is extremely resistant to tools. Below this clay-silt are sands, clays, and occasionally gravels, which at the site of the dam total 50–80 feet in thickness and rest on bedrock. At some of the slightly higher areas found in the bottomland, such as site J-18, there is a considerable admixture of sand. All such slightly higher land does not contain an appreciable amount of sand. No site was found at which there was not some sand present, although in some cases the sandy zone of occupation was covered by clay-silt.

A significant feature of the bottomland is the natural levee that borders the river. Portions of this levee will be noted on the map (Fig. 1), and more would be evident if the 70-foot contour had been plotted. This levee is not continuous but is an interrupted series of ridges. Varying considerably in width, they consist of stratified sands, clays, silts, and mixtures of these ingredients. Sometimes they contain limonitic zones. Their major component is sand. Frequently tongues of waterlaid sand extend westward from them away from the river.

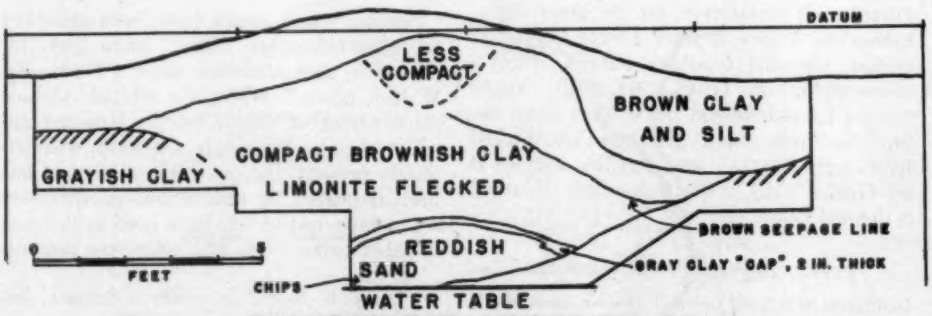


FIG. 2.—Site J-4, Profile of south end of mound.

These present levees are important archeologically because of a series of late sites found buried in them at a depth of 2 to 4 feet. These sites, J-2, 5, 7, 9, 22, 23, and 32, are all of the Fort Walton period, believed to be A.D. 1450–1650.[5] (Site J-10 is similar in time but not buried so deeply, probably because flood waters would flow across it instead of parallel to it, owing to the bend in the river where it is located.)

There are many indications that the Chattahoochee River has not always run in its present channel. Frequently sloughs tend to cut off bends of the river. Suggestions of these will be found on the map. The shape of Pope Lake (A in Fig. 1) and of the 60-foot contour around it are suggestive of an old riverbed. The series of lakes southeast of Butler (C-Gravel Pond, D-Blue Hole, E-Hog Wallow) have a southeasterly curve. They and the ridges south of them (dotted 70-feet contour) may indicate that the river at this point used to flow more to the west. The fact that Gravel Pond used to have a gravel bottom, now covered with silt, supports this theory.

Very early ceramic and preceramic sites, such as have been found on the banks of certain rivers of southeastern United States, notably the Tennessee, were not found on the lower Chattahoochee. It may be that the area did not supply sufficient inducement in the nature of food to attract immigrants in those times. A more likely hypothesis is that a few such early sites are present but were located on old banks now abandoned by the river and buried by subsequent floods.

There is no reason to believe the region would not have supplied adequate food for hunters. Deer, opossums, raccoons, skunks, squirrels, rabbits, turkeys and other birds, snakes, turtles, fishes, and shellfish are found there today. Bears, alligators, and to the north bison are reported by early travelers. No doubt the fauna was more varied in prehistoric times. Nuts, edible roots, and berries, still available, would supplement the diet.

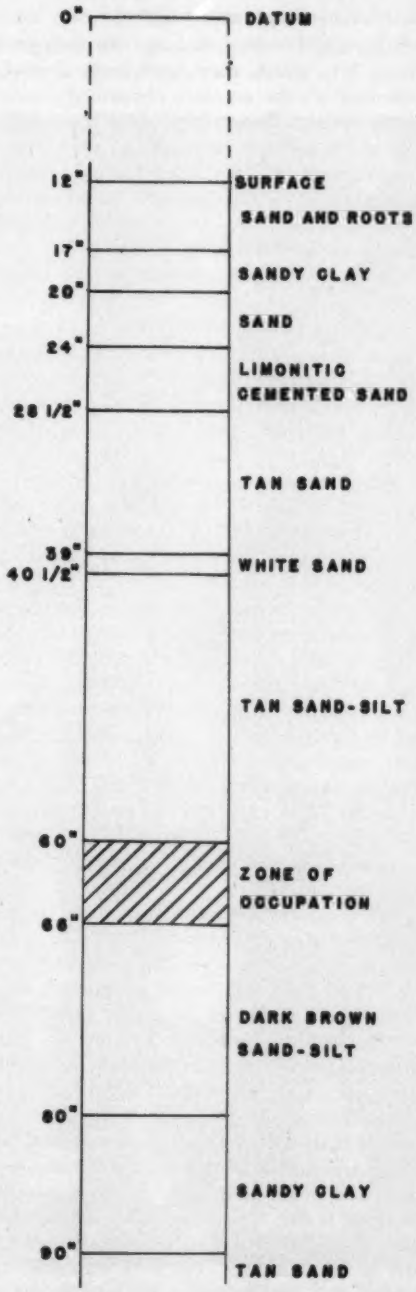


FIG. 3.—Site J-2, west profile of test 2.

[5] Goggin, 1948b, with minor changes by Bullen.

SUMMARY OF SITES

Sites will be discussed by chronological groups into which they have been divided, according to the ceramic chronology mentioned earlier. Reoccupied sites have been included under the more recent period unless evidence of the earlier one was much more abundant. The first group, consisting of those sites from which an insufficient sample was secured to permit cultural classification, has been designated "Indeterminate."

Indeterminate Sites

Two of the culturally indeterminate sites have mounds. The first, G-1, consists of a small, flat-topped, eroded point of land projecting westerly toward the Apalachicola River. Nearly at the top of the southern slope of this flat land is a clay mound, 15 feet across and 3 feet high. A corner-notched point (similar to Fig. 6, *g*) and chips found on the surface presumably belonged to builders of this mound.

The other mound site, J-4, is located in the bottomland on what appears to be an old river terrace or natural levee, 300 yards west of the present bank of the Apalachicola River. Numerous "mounds," naturally formed about roots of fallen trees, were noted during the survey. Three of the small hillocks at J-4 seemed different. One of the latter, 10 by 15 feet in area and about 30 inches high, was tested by means of a trench, 4 feet wide, dug across the southern end.

Fig. 2 shows a profile from this trench. This profile is not easy to interpret. Away from the mound a layer of brown clay and silt, 15 inches thick, rested on grayish clay. The upper 4 inches of the latter were blackish in color and suggestive of an old land surface. Below the mound there seems to have been some sort of pit. Chips of chert in the dome-shaped deposit of sand and the lack of decayed wood (such as was found in silted windfalls) in the brownish clay support the idea that this is a man-made mound. If the top of the sand deposit had been straight instead of domed, or if it had any of the bandings typical of waterlaid deposits, the profile might be interpreted as representing a buried slough. In that case the chips would be redeposited material.

In any event these data would indicate that man was in the Chattahoochee Valley before the deposition of the upper layer of brown clay and silt. If this deposit could be dated by geological means, an idea of the antiquity of man in the valley might be obtained. When any additional archeological work is done in the area, this mound should be reinvestigated.

Sites G-2 and G-3 are located on old river levees. Each produced chips and a heavy stemmed point. Seven sherds were found by tests in the southern part of G-3, possibly an extension of G-4, the large Fort Walton village and mound group at Chattahoochee Landing.

At J-6 chips, worked fragments, and five Wakulla Check Stamped sherds were collected. Tests at J-27, a slight elevation in the bottomland, produced chips and worked fragments. These chips are similar to those from nearby J-26 in that most are large and a high percentage include the limestone matrix. Both may be quarry sites. J-45 is a small but high sandy knoll. Here two sherds of Plain, Fort Walton paste were found in a test hole, but additional tests failed to uncover more.

J-41, an eroded area along the road, is of interest because of possible association between heavy stemmed points and pottery. Sherds are tempered with very fine sand. One, badly eroded, may once have been simple stamped. Another is a thick, crude-appearing rim exhibiting what appears to be a Deptford simple stamp. Rim treatment is reminiscent of Franklin Plain.

Little can be said about other sites in this group. All are areas where Indian material had eroded from the thin sandy mantle that covers the red clay. J-33 produced one Wakulla Check Stamped and 12 residual plain sherds; J-34, chips, one Wakulla Check Stamped and 3 plain, sand-tempered sherds; J-36, chips, a rough triangular blade, and two plain, sand-tempered sherds. J-8, J-11, J-13, J-14, J-15, J-16, J-21, and J-24 produced only chips and worked fragments. At J-19 two heavy stemmed points but no chips were found. J-14 is unique as a piece of burnt daub was found there. Some of these sites may represent preceramic occupation of the valley.

Santa Rosa–Swift Creek Sites

Two sites are included here for this period. Reoccupied Santa Rosa–Swift Creek sites will be found among Leon-Jefferson sites (J-3) and among Lower Creek (?) sites (J-46, J-47, and probably J-50).

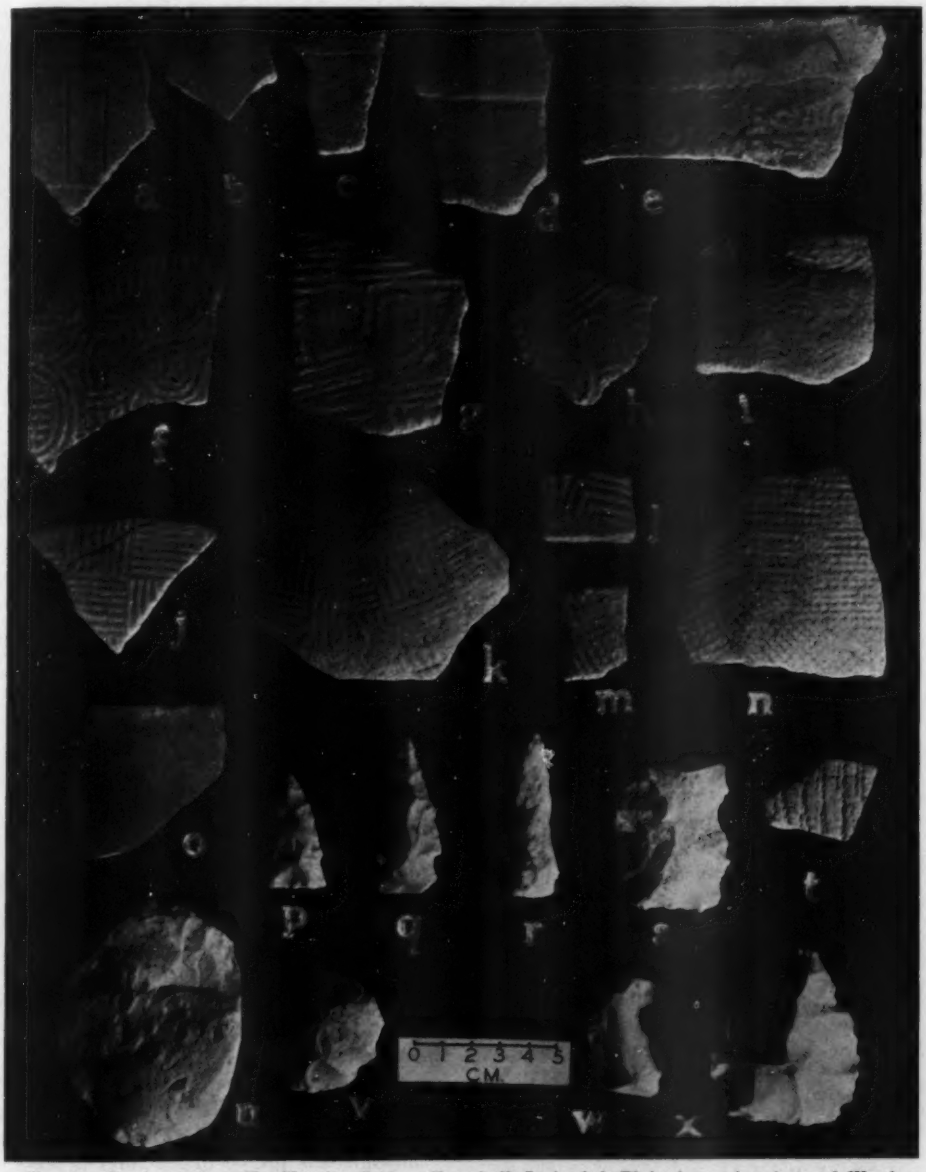


FIG. 4.—Specimens from Tan Vat site, J-18: *a*, Carrabelle Incised; *b*, Plain, incurving rim; *c*, *d*, Weeden Island Plain; *e–i*, Swift Creek Complicated Stamped (*e*, late; *i*, early); *j*, *k*, St. Andrews Complicated Stamped; *l*, Crooked River Complicated Stamped; *m*, *n*, Gulf Check Stamped; *o*, Franklin Plain; *p–r*, projectile points; *s*, fragment of knife; *t*, West Florida Cord Marked; *u*, hammerstone; *v*, *w*, utilized chaips; *x*, rough trianguloid blade.

J-18 or the Tan Vat site is a small undisturbed village of the very late Santa Rosa–Swift Creek period. It is located on a low knoll in the bottomland of the eastern side of Tan Vat Pond, which may have been the channel of the Chattahoochee River when the site was occupied (Fig. 1).

The profile consisted of brown sandy clay underlaid by compact grayish-yellow clay. The superior zone varied from 6 to 16 inches in thickness, depending on the elevation of the surface. Where thick it could be divided into two parts—an upper sterile portion 6 inches thick and a lower zone of occupation 8–10 inches thick.

Two stratigraphic tests, one 4 by 4 and the other 5 by 5 feet, were troweled in this midden using arbitrary levels. The site seemed homogeneous, but Carrabelle Incised, plain incurving rims, and thickened rims on Swift Creek Complicated Stamped sherds (Fig. 4, *a*, *e*) were found only in the upper part of occupational deposits.

Specimens from this site, illustrated in Fig. 4, include 4 Weeden Island Plain, 1 Carrabelle Incised, 35 early type and 6 late type Swift Creek Complicated Stamped, 7 early type and 2 late type St. Andrews Complicated Stamped, 2 early type Crooked River Complicated Stamped, 1 early type West Florida Cord Marked, 23 Gulf Check Stamped, 1 Franklin Plain, 39 indistinct stamped, 1 miscellaneous incised, and 164 plain, sand-tempered sherds; 454 chips, 1 core, 2 utilized flakes, 3 worked fragments, 2 hammerstones, 1 rough, thick, trianguloid blade, and 3 side-notched projectile points. Two fragments of quartz pebbles, 2 broken rocks, some fragments of calcined bone, and a piece of charred worked wood complete the available inventory.

Pottery from this site is representative of very late Santa Rosa–Swift Creek at a time when ceramic development was tending strongly toward Weeden Island. Exterior folded or thickened rims, usually considered typical of Weeden Island, are first found in a Santa Rosa–Swift Creek context (Willey and Woodbury, 1942, p. 241), while there is unpublished evidence that an early form of Carrabelle Incised is present in pre-Weeden Island times.[6] Weeden Island Plain rims are not so well smoothed as they are at Weeden Island sites (compare Fig. 4, *c*, *d*, with Fig. 5, *a*, *b*). Sherds from the Tan Vat site contain mica inclusions in their paste.

Attention is called to the three projectile points (Fig. 4, *p–r*). It will be noted that two of them are similar in having shallow side notches. The third, while unfinished, suggests the same form. This is the first recorded instance in which projectile points have been definitely associated with Santa Rosa–Swift Creek pottery in Florida.

The Tan Vat site may be the village of Indians who built a mound leveled by Moore in 1906. Moore placed his "Mound near Kemp's Landing" one mile south-southeast of that landing (J-10 on map). This would locate it about half a mile southeast of the Tan Vat, but search did not reveal its location.

Regarding a large deposit of pottery found in the eastern part of this mound, Moore (1907, pp. 428–429) wrote, "Decoration, when present, consists of the small check stamp; the complicated stamp, faintly impressed; very rude incised line decoration in two instances in sherds; in one case an incised decoration of wavy lines and punctate markings as shown in Fig. 1." Except for the one vessell illustrated by Moore, which is a divergent variety of Indian Pass Incised, this description would apply to pottery from the Tan Vat site.

Site J-26 has been assigned to a Santa Rosa–Swift Creek time horizon on the basis of a single St. Andrews Complicated Stamped sherd. Such designation is, of course, subject to question. The site is located on a slight rise of the bottomland adjacent to a small lime sink (Fig. 1).

Four tests were dug covering 40 square feet. Profiles showed a surface zone of sterile reddish brown clay, 12 inches thick; next, brown sandy clay, 6 inches thick, containing chips, bits of charcoal, and the one sherd; thirdly, clayey sand, 22 inches thick, in the lower 16 inches of which chips and rarely charcoal were found; and finally compact red clay.

Though this profile might infer a preceramic zone, such seems dubious in view of the lack of artifacts and the character of the chips. Most chips were large and 40 per

[6] John W. Griffin, personal communication.

cent included the lime matrix. At the Tan Vat site a majority were small and only 10 per cent exhibited this matrix. It seems reasonable to believe J-26 to be the remains of Indian exploitation of the supply of chert which might be found at a lime sink.

Weeden Island Sites

Table 1 lists material from eleven sites considered to belong to a Weeden Island horizon. One Lower Creek (?) site, J-48, was also occupied by Weeden Island people.

In some cases, particularly J-25 and J-35, allocation is based on a minimum of evidence as Wakulla check stamped pottery is fairly common at Fort Walton sites in this area. In these cases some consideration has been given to lack of mica in pottery paste. As will be seen, mica is prominent in Fort Walton pottery of the lower Chattahoochee valley.

TABLE 1.—MATERIAL FROM 11 WEEDEN ISLAND SITES

Specimens	J-12	J-17	J-20	J-25	J-31	J-35	J-37	J-38	J-39	J-40	J-44
Chert:											
Chips	80	310	3	47	131	19	150	4	5	23	26
Cores		5			2						
Utilized flakes		2			6						
Worked fragments		8	1	2	10		2				1
Tools, see lists in text		16	1		14		2				
Quartz:											
Chips							1				1
Fragments of pebbles		4		1		1				1	
Hammerstones		3		1							
Quartzite:											
Broken fragments		2									
Hammerstones		1									
Hematite											1
Steatite					3		1				
Shells:											
Fresh-water snails								x		x	
Fresh-water clams		x							x	x	
Busycon		1									
Pottery:											
Weeden Island Red		5						1			
Weeden Island Incised		1			1						
Weeden Island Punctated		4									
Weeden Island Plain	2	39						1			2
Carrabelle Incised	2	12	4								1
Carrabelle Punctated	2	9			1			1	1		1
Swift Creek Complicated Stamped (Late)		24	1								1
Keith Incised		6									
Wakulla Check Stamped		92		26		16	2	13	24	13	
Miscellaneous:											
Incised		5		1							
Punctated		9			1						
Stamped		15						5		1	1
Cord-marked		1									
Smooth Plain		167					16	3	3	5	16
Plain, sand-tempered	23	300	28	93	10	13	1	33	10	5	8
Roughened surface, Fort Walton paste		39(2)							2		
Plain, Fort Walton paste		32(4)		5(5)	1	1			1		
TOTAL SHERDS	29	760	33	125	14	30	19	57	41	24	30
Pottery disk		1									
English stoneware, early nineteenth century				10							

x—present in fair quantities.

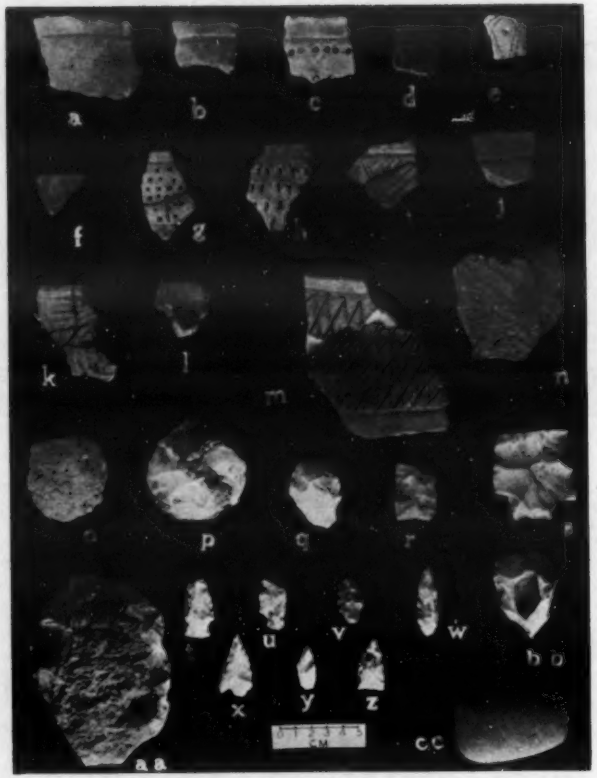


FIG. 5.—Specimens from Butler site, J-17: *a*, *b*, Weeden Island Plain; *c–e*, Weeden Island Punctated; *f*, Weeden Island Incised; *g*, *h*, Carrabelle Punctated; *i*, Carrabelle Incised; *j*, Wakulla Check Stamped; *k*, *l*, Swift Creek Complicated Stamped (Late Variety); *m*, Keith Incised; *n*, roughened surface, Fort Walton paste; *o*, pottery disk; *p*, chipped chert disk; *q*, utilized flake; *r*, fragment of asymmetric trianguloid knife; *s*, fragment of stemmed knife; *t–z*, projectile points; *aa*, hoelike tool; *bb*, scraper, *cc*, celt.

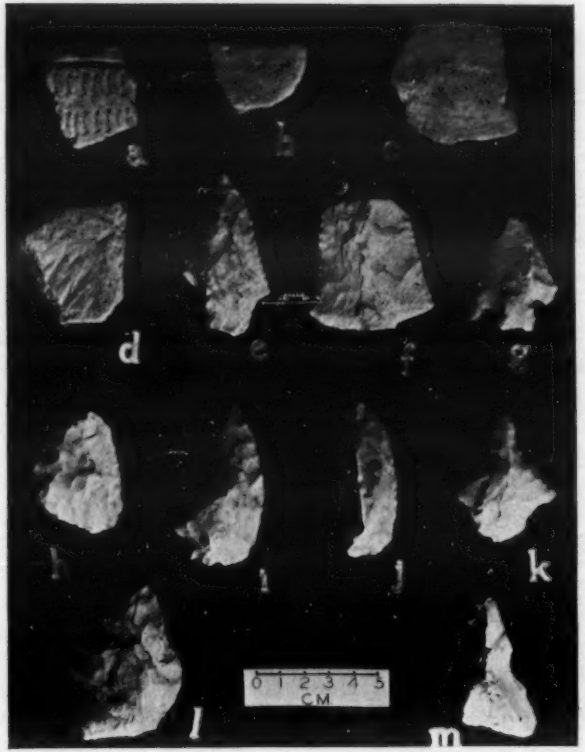


FIG. 6.—Specimens from Wilson site, J-31: *a*, Carrabelle Punctated; *b*, Weeden Island Punctated; *c*, Plain, sand-tempered; *d*, fragment of steatite vessel; *e*, *g*, projectile points; *f*, fragment of stemmed knife; *h*, *i*, ovate scrapers or knives; *i*, unfinished tool; *j*, side scraper; *k*, drill; *m*, shaft scraper.

Material listed for J-12 came from a small knoll in a plowed field.

The Butler site or J-17 is the largest and most important of the Weeden Island group. Owing to the presence of Wakulla Check Stamped sherds, it must be considered representative of Weeden Island II. Fig. 5 shows some of the specimens collected.

This site is located on the upland, one-half mile south-southeast of Butler, on the top and eastern slope of a low ridge. At the foot of the slope is a large water hole which, in recent years at lest, has never run dry and is, presumedly, spring fed. About 3 acres of this slope is littered with sherds, chips, tools, and fresh-water clam shells. Soil consists of dark brown, coarse sandy loam resting on coarse reddish sand. Unfortunately, long cultivation with attendant slope wash has completely ruined this midden for scientific excavation.

Stone tools, in addition to those listed in the foregoing tabulation, include another hammerstone (not illustrated), a chipped disk, an asymmetric trianguloid knife, a large stemmed knife, seven projectile points, a hoe-like tool, three scrapers, all of chert, and a polished celt of granite (Fig. 5, *p*, *r-cc*, respectively). The latter, or the material for it, must have been imported into Florida as granite is not a native rock.

One of the projectile points (Fig. 5, *t*) is side notched and of the same type as those found at the Santa Rosa–Swift Creek Tan Vat site, J-18 (compare with Fig. 4, *q*). Shapes of the others may be noted from the illustration. Their relatively small size, 1–2 inches in length, implies use of the bow and arrow by Weeden Island II times.

Relatively large amount of late Swift Creek Complicated Stamped sherds may indicate this type to persist later in the Chattahoochee Valley than near the coast where Willey and Woodbury made their tests. Lack of other Weeden Island I complicated stamped sherds is to be noted.

Slightly less than 10 percent of the sherds from the Butler site have been classified as having been made of Fort Walton paste. These may represent inferior workmanship, as the paste of some of these sherds is not markedly different from that of some sherds decorated in typically Weeden Island style. On the other hand, presence of a small number of sherds with a whitish surface, while statistically insignificant, may indicate use of this site during Lower Creek (?) times.

At J-20 chips and sherds were found on the eroded surface of a road. The lower part of a pit, dug into the now exposed red clay, was noted.

At J-25 chips and sherds had eroded out of sandy clay which overlaid red clay, on both sides of an erosion gully. Also on the eroded surface were parts of a cast-iron stove, sherds of the early nineteenth century, English stoneware (blue-edged and blue on white Staffordshire), fragments of old glass bottles, and part of a modern glass tumbler. The latter was probably from a nearby cabin.

All aboriginal sherds from this site, except the five Plain, Fort Walton paste, are substantially eroded. These five are not eroded and, as indicated in the table, have the whitish surface color characteristic of Chattahoochee Brushed. This pottery is believed to be post-Fort Walton in date and to represent a Lower Creek (?) component. As will be explained later, J-25 is in the area occupied from about 1819 to 1838 by a group of Indians under Econchatimico. Blue-edged Staffordshire was made in England after about 1810. There is the possibility, therefore, that the English stoneware and perhaps the whitish aboriginal ware were used by some of Econchatimico's people.

Specimens from J-31, the Wilson site, were found on the eroded red clay slope of a ridge on the uplands adjacent to a dry brook bed. While the sample is small, sherds have a paste similar to that of pottery from the Tan Vat site (Santa Rosa-Swift Creek). This detail and the lack of Wakulla Check Stamped sherds implies that this site is Weeden Island I in date. Specimens are illustrated in Fig. 6.

To judge from available samples, there seem to be differences in types of projectile points from this site compared with those from the Butler site, J-17 (compare Figs. 5 and 6). Perhaps the bow was not in general use until Weeden Island II times. Chert specimens, other than those listed in Table 1, include a heavy (thick) stemmed point with serrated edges, a fragmentary knife or lance point, two points with deep corner notches, two thin ovate knives or scrapers, an unfinished blade, three side scrapers, a drill, two thick ovate scrapers, and a shaft

of stemmed knife; *t-z*, projectile points; *aa*, hoelike tool; *bb*, scraper, *cc*, celt.

scraper (Fig. 6, *e–m*, respectively). Notches at the sides of the latter are worked.

J-35 is a cultivated field, now overgrown with trees, on an early river levee or terrace in the bottomland.

J-37 is on a little rise in the bottom land. The profile, from top to bottom, consisted of black-brown coarse sand, 10 inches thick, in the lower 3 inches of which chips and sherds were found; brown coarse sand, 12 inches thick, which also contained chips and sherds; a tan or slightly mottled zone of coarse sand, 18 inches thick, which contained chips and pits and post holes (?) extending downward from the zone above; and, finally, coarse limonitic cemented sand in one test, coarse white sand in the other.

There was no difference in sherds from the lower part of the black-brown sand. A large blade, 4½ by 2 inches, was found at a depth of 18–20 inches in the lower part of the brown sand and the basal portion of a stemmed point at a depth of 53 inches in what appeared to be an old burned-out stump.

Area covered by tests was not sufficient to decide if this site had a preceramic zone. Many of the chips included the limestone matrix. Immediately south of J-37, lime-

TABLE 2.—MATERIAL FROM 9 FORT WALTON SITES

Specimens	G-4	J-2	J-5	J-7	J-9	J-10	J-22	J-23	J-32
Chert:									
Chips	184	47	10				1	4	1
Worked fragments	7								
Quartz:									
Chips		2	1						
Fragments of pebbles	7	2							
Hammerstones			1						
Charred corn cob			1						
Pottery:									
Chattahoochee Brushed	2(1)	3(1)						10	
Alachua Cob Marked	4							2	
Combination Cob Marked and Wakulla Check Stamped								1	
Miller Plain	7								
Lamar Complicated Stamped(?)				1					
Fort Walton Incised	1	42	5	1		1		5	6
Pinellas Incised, B		16	3						
Lake Jackson Fingernail Impressed (?)		1	1						
Combination Pinellas Incised and Lake Jackson Fingernail Impressed(?)		1							
Lake Jackson Plain		7	2(1)					1	
Wakulla Check Stamped	45	36	32	1	4	9	8	10	
Plain, Fort Walton paste	118(8)	755	164	8	4	32	6	47	31
Notched rims, Fort Walton paste		26	4					1	2
Handles, Fort Walton paste		2	2						
Miscellaneous:									
Burnished surface		13	2						
Fine incised festoons and guilloches		2							
Incised	3	13	3		1			3	1
Punctated		3							
Cord or textile impressed	2								
Stamped	8	3							
Large check stamped	1							1	1
Roughened surface	8	11		2		1			1
Pensacola Incised				1					
Plain, shell-tempered		3	3	2				3	5
Plain, limestone-tempered	2	1	3						
Rim sherd with node, 1½ inches below rim					1				
Deptford Simple Stamped(?)		1							
Gulf Check Stamped		3	1						
Tetrapod, Gulf Check Stamped		1	1						
Combination Gulf Check and Swift Creek Complicated Stamped		1							
Plain, sand-tempered	8	12	8						
TOTAL SHERDS	209	956	234	16	10	43	14	84	47

stone containing chert nodules outcrops above the 80-foot contour (at J-19). Quarried material brought to the Harrell site could be mixed to considerable depths in coarse sand by aboriginal disturbance.

J-38 and J-39 probably refer to parts of the same site as they are located on opposite sides of a small brook. These locations are cultivated fields, fallow at the time of the survey. They are said to have produced many Indian artifacts. Snail shells are *Campeloma ponderosum* Say.[7] Tests indicated no aboriginal remains below the plowed zone.

J-40 is another old cultivated field, now in high grass and small pines. Snails are *Campeloma ponderosum* Say.

Trees and patches of grass cover J-44, which is located on what seems to be an old river terrace. Specimens were excavated from a blackish-brown occupation zone, 6 inches thick, the top of which was 8 inches below the surface. Above and below this zone was brown, medium coarse sand. This site appeared to cover several acres but no concentration was located.

Fort Walton Sites

Material from nine Fort Walton sites is listed in Table 2. Examination of the map will show that all are located on present river banks.

Chattahoochee Landing (G-4 in Fig. 1) on the east bank of the Apalachicola River, just south of Route 90, was visited by Moore in 1902. He reports a total of seven mounds, all of the residential type. The largest, at the time of his visit supported several frame buildings (Moore, 1903, pp. 491–492). This is probably the same one which in 1838 was the location of a tavern (de Castelnau, 1948, p. 206).

Today, five mounds and a midden or Indian refuse deposit, about 30 inches thick, may be seen at the landing. These mounds are of the flat-topped, platform type built by Indians as foundations for buildings. They vary from 30 to 80 feet across and from 5 to 20 feet in height, approximately. One has a trench, 20 feet wide, dug, presumedly by Moore, through its central portion.

[7] Kindly identified by William J. Clench, Museum of Comparative Zoology, Cambridge, Mass.

Sherds from the mound group and midden were segregated by areas but significant differences did not appear from this analysis. Many Wakulla Check Stamped sherds from this site have a distinct linearity to the stamping. Included under "Miscellaneous, stamped" are five which would be called Deptford Linear Check Stamped except that they are made of Fort Walton paste. Some micaceous paste is included in the collection.

The Jim Woodruff site, or J-2, is located where the dam meets the west bank of the Apalachicola River. Here the natural levee is about 150 feet wide. Occupation extended 650 feet along this levee and from the river bank at least 65 feet to the west. A small slough used to cross the site, draining lower land to the west. Slope of the occupation zone near this slough indicates it was present during Indian habitation. Thus the Jim Woodruff site offered Indians plenty of land for agriculture and potable water other than the Apalachicola River. The slough would also be a convenient place at which to draw up canoes.

Specimens, illustrated in Fig. 7, came from three places; the eroded bank of the river, an area from which the overburden had been removed by bulldozers, and tests dug during the survey. It is probably significant that no early sherds (Deptford and Gulf Check Stamped, Fig. 7, *w–z*) were found in tests.

Occupational debris are buried under 4 feet of more recent alluvium. This is considerable when it is remembered that this site is relatively late, circa 1600. Profiles varied from test to test in respect to sand and sandy deposits in the upper portion of overburden. Fig. 3 shows the west profile from test 2. Sediments of the zone of occupation did not differ from those immediately above or below, except for being darkened by charcoal and, presumedly, nitrogenous material.

The fact that habitational debris were found in the middle of a sand-silt zone is important. This same zone was found at many places along the Chattahoochee River. All Fort Walton sites to be mentioned, except J-10, were similarly situated in this sand-silt stratum. This implies that they were all established at about the same time, after the deposition of this zone had started, and were all abandoned before this particu-

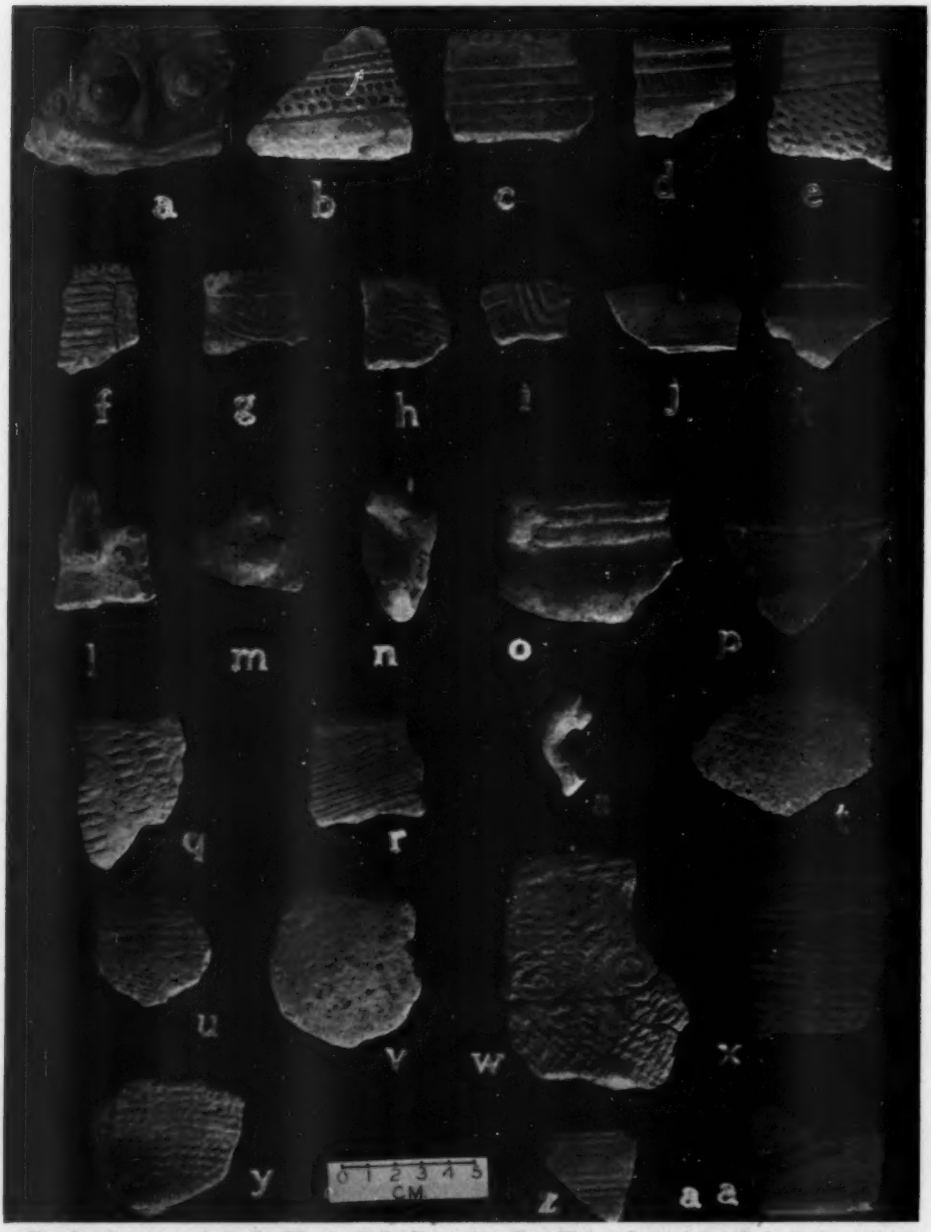


FIG. 7.—Specimens from Jim Woodruff site, J-2: *a–k*, *p*, Fort Walton Incised; *l–n*, Lake Jackson Plain; *o*, Pinellas Incised; *q*, Lake Jackson Fingernail Impressed (?); *r*, Wakulla Check Stamped; *s*, handle; *t*, roughened surface; *u*, pottery disk, scored surface; *v*, pottery disk, shell-tempered; *w*, combination Gulf Check and Swift Creek Complicated Stamped; *x*, *y*, Gulf Check Stamped; *z*, Deptford Simple Stamped; *aa*, hone.

lar deposition was completed. It is also undoubtedly true that this deposit formed excellent agricultural land.

At some of the natural levees of the lower Chattahoochee River a sand-silt zone was not found. Opposite Rambo Island and at Neals Landing recently(?) deposited layers of sand, clayey sand, and, occasionally, clay reach a total thickness of ten feet. Both a sand-silt deposit and evidence of Indian occupation were absent at such places.

Occupational debris at the Jim Woodruff site produced many sherds, much charcoal, occasional bits of calcined bone, and a few chips. Scarcity of the latter implies a much greater dependence on agriculture for food than in the case of Santa Rosa-Swift Creek and Weeden Island sites previously described. Not included in Table 2 are fragments of sandstone, a sandstone hone (Fig. 7, *aa*), and three disks made from sherds. One disk had a scored surface and another was shell-tempered (Fig. 7, *u–v*).

North of the dam a section, 15 feet long, was cleared. In this face two post holes and two small pits could be seen. Two pieces of clay daub from house walls, exhibiting concave surfaces, were also found. Undoubtedly, Indians had houses at this site.

In one test, 5 by 10 feet, which produced 298 sherds, the zone of occupation was removed in two arbitrary layers. Significant differences were not sharp but it is worthwhile to record that four Lake Jackson Plain, one Wakulla Check Stamped, a shell-tempered sherd, one with fine incised festoons and another with fine incised guilloches were in the upper half. Fort Walton Incised and Pinellas Incised B were in both zones. The face of a frog effigy vessel (Fig. 7, *a*) was in the lower half. Similar relatively shallow and, presumedly, relatively late provenience for the first three items will be mentioned later for two other Fort Walton sites.

All except shell-, sand-, and limestone-tempered sherds contained mica in their paste. A comparison of the ceramic inventory from the Jim Woodruff site with that from Chattahoochee Landing indicates certain similarities and differences. The latter undoubtedly reflect the sizes of the respective samples.

J-5 is comparable to the Jim Woodruff site in many ways. It is, however, much smaller, as the levee is only about 50 feet wide. As before, the habitation zone, 8 inches thick, is the central portion of a dark brown sand-silt stratum. Overburden is only 34 inches instead of 4 feet thick. Twenty-six different layers of sands and clayey sands were counted in this overburden.

Three tests, totaling 35 square feet, were dug and specimens removed by arbitrary levels. As at the Jim Woodruff site, Lake Jackson Plain and shell-tempered sherds were limited to the upper half. Wakulla Check Stamped sherds were found in both zones.

The ceramic inventory from this site parallels that from the Jim Woodruff site very closely. Most sherds contain micaceous paste. Evidence was also found for two shallow pits and four post holes. The latter, 8 inches in diameter, extended 9 inches below the habitation zone and, while not forming a straight line, roughly paralleled the river bank.

At this site we do not have to imply agriculture from the small number of chips, as a charred ear of corn was found. This is the first aboriginal corn known to science from Florida. Deer bones and fresh water clam shells testified to other sources of food. A fragment of polished stone, possibly part of an ornament, was also found.

What appeared to be a small mound was found about 120 feet north of tests made at J-5. A trench proved this to be a natural accumulation of dirt around the roots of a tree that had fallen toward the river. The charred trunk, buried under 20 inches of waterlaid sand, appeared to be that of a water oak. From slope of strata and from a downward dip in the Indian habitation zone, it appeared that the bank of the river, at this point, had moved eastward 21 feet since occupancy of this site.

Three of the "Plain, sand-tempered" and both the body and tetrapod Gulf Check Stamped sherds, shown in Table 2 for this site, were found in association with the disturbance caused by this tree.

Site J-7 is smaller than the two previous ones. As before, the zone of occupation, 6 inches thick, is in the center of a brown sand-silt deposit. Overburden is 30 inches thick. All sherds, including sand-tempered ones, have mica particles in them.

The situation at J-9 is similar to that at those just mentioned. Waterlaid sands and clayey sands, 27 inches thick, overlay brown sand-silt. The habitation zone, only 4 inches thick and relatively unproductive, was 14 inches below the top of the sand-silt. All sherds contain micaceous inclusions.

At Kemps Landing, where J-10 is located, the geological situation is radically different. Laminated sands and clayey sands are not present. Presumedly, this is because flood waters would tend to erode rather than deposit due to the bend in the river.

The site is located on what appears to be part of an old river terrace. At the site this terrace is composed of a brown clay-silt zone, 16 inches thick, which contains some sand and rests on red clay. The lower part, between depths of 8 and 15 inches, is darkened by charcoal and contains a few chips and sherds having micaceous paste. A late nineteenth-century nail was found in the upper 4 inches of one test.

At Butlers Ferry, where J-22 is located, there has been a lot of activity by settlers during the last 100 years. Profiles differed substantially from test to test.

In one test Indian items were found in the

FIG. 8.—Specimens from Bellamy site, J-32: Sides, fragments of *Busycon* shells; top sherd, Plain, Fort Walton paste; middle sherd, Fort Walton Incised; lower sherd, Plain, shell-tempered; bottom, patinated flint tool.

FIG. 9.—Restored Fort Walton Incised vessel from Bellamy site, J-32.

middle of a dark brown silty zone, 13 inches thick, which was overlaid by 18 inches of waterlaid sands and clayey sands. In the latter, at a depth of 12 inches, some charcoal was found. This charcoal can be correlated with recent activities as nails, iron, and fragments of glass bottles were found at the same relative position in other tests.

At J-23 evidence of two sequential occupations, both during the Fort Walton period were discovered. The levee is about 30 feet high and rather broad. These seem to be desirable features of a site. It is not surprising that the amount of Indian debris is reminiscent of the Jim Woodruff and J-5 sites where these features were also present.

The profile consisted of laminated yellow or red sands, 23 inches thick; a zone of brown silty sand, 17 inches thick; and, at the bottom of test holes, gray sand. The lowest 3 inches of brown silty sand formed the lower occupation zone. A sterile zone, 3 inches thick separated it from a superior occupation zone, 5 inches thick.

Here, as at the Jim Woodruff and J-5 sites, Lake Jackson Plain and shell-tempered sherds were found only in the upper zone. All, except Chattahoochee Brushed, cob-marked, and shell-tempered sherds have micaceous paste. Attention is called to the combination cob-marked and Wakulla Check Stamped sherd listed in Table 2 for this site.

J-32 is the most northern Fort Walton site located by the survey. As usual, occupational debris were found in a zone, in this case 8 inches thick, which formed the mid-portion of a brown sand-silt deposit. This deposit, 21 inches thick, rested on gray sand and was overlain by yellow and white sands and clayey sands totaling 21 inches in thickness.

Tests uncovered what may have been a "ceremonial" deposit. Large sherds of a restorable Fort Walton Incised vessel (Fig. 9), overlapping each other, were found inverted over a small deposit of bones. Two *Busycon* shells (Fig. 8) had been placed on top of these sherds. At the base of the "cache," possibly fortuitiously, were a retouched, patinated flint tool (Fig. 8), four Plain, Fort Walton paste, and two shell-tempered sherds. The only preservable bone was a rib, similar to that of a small deer. In the dark, charcoal-impregnated midden, it was impossible to determine whether or not this "ceremonial" deposit was intentionally placed in a shallow pit. Slight changes in color, here

The situation at J-9 is similar to that at those just mentioned. Waterlaid sands and clayey sands, 27 inches thick, overlay brown sand-silt. The habitation zone, only 4 inches thick and relatively unproductive, was 14 inches below the top of the sand-silt. All sherds contain micaceous inclusions.

At Kemps Landing, where J-10 is located, the geological situation is radically different. Laminated sands and clayey sands are not present. Presumedly, this is because flood waters would tend to erode rather than deposit due to the bend in the river.

The site is located on what appears to be part of an old river terrace. At the site this terrace is composed of a brown clay-silt zone, 16 inches thick, which contains some sand and rests on red clay. The lower part, between depths of 8 and 15 inches, is darkened by charcoal and contains a few chips and sherds having micaceous paste. A late nineteenth-century nail was found in the upper 4 inches of one test.

At Butlers Ferry, where J-22 is located, there has been a lot of activity by settlers during the last 100 years. Profiles differed substantially from test to test.

In one test Indian items were found in the

FIG. 8.—Specimens from Bellamy site, J-32: Sides, fragments of *Busycon* shells; top sherd, Plain, Fort Walton paste; middle sherd, Fort Walton Incised; lower sherd, Plain, shell-tempered; bottom, patinated flint tool.

FIG. 9.—Restored Fort Walton Incised vessel from Bellamy site, J-32.

middle of a dark brown silty zone, 13 inches thick, which was overlaid by 18 inches of waterlaid sands and clayey sands. In the latter, at a depth of 12 inches, some charcoal was found. This charcoal can be correlated with recent activities as nails, iron, and fragments of glass bottles were found at the same relative position in other tests.

At J-23 evidence of two sequential occupations, both during the Fort Walton period were discovered. The levee is about 30 feet high and rather broad. These seem to be desirable features of a site. It is not surprising that the amount of Indian debris is reminiscent of the Jim Woodruff and J-5 sites where these features were also present.

The profile consisted of laminated yellow or red sands, 23 inches thick; a zone of brown silty sand, 17 inches thick; and, at the bottom of test holes, gray sand. The lowest 3 inches of brown silty sand formed the lower occupation zone. A sterile zone, 3 inches thick separated it from a superior occupation zone, 5 inches thick.

Here, as at the Jim Woodruff and J-5 sites, Lake Jackson Plain and shell-tempered sherds were found only in the upper zone. All, except Chattahoochee Brushed, cob-marked, and shell-tempered sherds have micaceous paste. Attention is called to the combination cob-marked and Wakulla Check Stamped sherd listed in Table 2 for this site.

J-32 is the most northern Fort Walton site located by the survey. As usual, occupational debris were found in a zone, in this case 8 inches thick, which formed the mid-portion of a brown sand-silt deposit. This deposit, 21 inches thick, rested on gray sand and was overlain by yellow and white sands and clayey sands totaling 21 inches in thickness.

Tests uncovered what may have been a "ceremonial" deposit. Large sherds of a restorable Fort Walton Incised vessel (Fig. 9), overlapping each other, were found inverted over a small deposit of bones. Two *Busycon* shells (Fig. 8) had been placed on top of these sherds. At the base of the "cache," possibly fortuitiously, were a retouched, patinated flint tool (Fig. 8), four Plain, Fort Walton paste, and two shell-tempered sherds. The only preservable bone was a rib, similar to that of a small deer. In the dark, charcoal-impregnated midden, it was impossible to determine whether or not this "ceremonial" deposit was intentionally placed in a shallow pit. Slight changes in color, here

and there, suggested such to have been the case.

At this site some mica was found in all sherds, including shell-tempered ones.

Leon-Jefferson Sites

Two sites have been assigned to the Leon-Jefferson period based upon surface collections. The lack of many Fort Walton pottery types in their inventories should be noted. In contra-distinction to Fort Walton sites of this area, mica is present only in Wakulla Check Stamped, Swift Creek Complicated Stamped, and simple stamped sherds. Examination of the lists will indicate that 18 percent of all sherds, 29 percent if sand-tempered sherds are eliminated (presumedly, they belong to an earlier period), have a whitish surface color. Application of this wash(?) is not limited to any specific pottery type.

Site J-1 occupied a knoll, on the uplands, which had been leveled in connection with building operations. Soil consisted of very coarse sand. The available inventory includes: 1 Ocmulgee Fields Incised, 1 Jefferson ware rim, 3 Miller Plain, 13(4) Plain, Fort Walton paste, and 4 Plain, shell-tempered sherds; 20 chips, 2 utilized flakes, and 1 worked fragment.

Site J-3 covers about ten acres on land of the State Hospital Farm. As at J-1, the chief constituent of soil is coarse sand. Specimens, illustrated in Figure 10, include: 22(8) Chattahoochee Brushed, 4 Alachua Cob Marked, 1 Cob Marked over Chattahoochee Brushed, 3 Spanish, 6 Mission Red Filmed, 19(13) Ocmulgee Fields Incised, 9(6) Jefferson Ware Rims, 8(4) San Marces Stamped (Cross Simple), 1 Aucilla Incised (limestone-tempered), 31 Miller Plain, 2 Lake Jackson Plain, 47 Wakulla Check Stamped, 157(65) Plain, Fort Walton paste, 6(6) interior red painted, 1 scored interior red painted, 19(7) Walnut Roughened, 16 miscellaneous incised and stamped, 2 scored, shell-tempered, 21 plain, shell-tempered, 9(5) plain, limestone-tempered, 13 Deptford Simple Stamped, 37 Swift Creek Complicated Stamped, and 193 Plain, sand-tempered sherds; 199 chips, 4 worked fragments, 2 scrapers, 4 projectile points, 1 chipped hoelike tool, a quartz hammerstone, and limestone hone.

Spanish, Mission Red Filmed, and other sherds date occupation by Indians as roughly contemporaneous with Spanish missions near Tallahassee where similar pottery has been found, circa 1633–1704 (Smith, 1948, pp. 316–318). Bishop Calderón of Cuba in a letter to the Queen of Spain states that a mission was established on the upper Apalachicola River in 1675 (Wenhold, 1938, p. 9). It may have been at site J-3. Indians may have continued living here after mission times. The pottery inventory also indicates an occupation during the Santa Rosa–Swift Creek period.

Presence of two Lake Jackson Plain sherds is interesting. As has been mentioned in the preceding section, Lake Jackson Plain, albeit in small quantities, was found only in the upper zones of three Fort Walton sites along the Chattahoochee River. It is not surprising, therefore, to find it here at a site whose major occupation occurred during the succeeding period. This occurrence tends to confirm the stratigraphic evidence that Lake Jackson Plain is a very late Fort Walton pottery type.

Wakulla Check Stamped sherds and some of the projectile points are suggestive of Weeden Island. Lack of other Weeden Island pottery types, however, implies Wakulla Check Stamped vessels to be, like Lake Jackson Plain, holdovers from Fort Walton. Indians from this area, attracted to Spanish missions near Tallahassee, may have been the ones who made Leon Check Stamped pottery found at the San Francisco de Oconee mission. A few of the Jefferson Ware sherds from that mission have a whitish surface color. They may also indicate a similar connection.

Two tests, each 5 by 10 feet, were dug to learn what types of pottery might be found below the base of cultivation. Swift Creek Complicated Stamped, Deptford Simple Stamped, many Plain, sand-tempered, and two Plain, Fort Walton paste sherds were uncovered below the plow line. These tests substantiate implications from the surface collection that this site had a Santa Rosa–Swift Creek occupation prior to Leon–Jefferson times.

It may also be suggested that two periods are represented by stone objects from this site. No doubt the small, narrow triangular

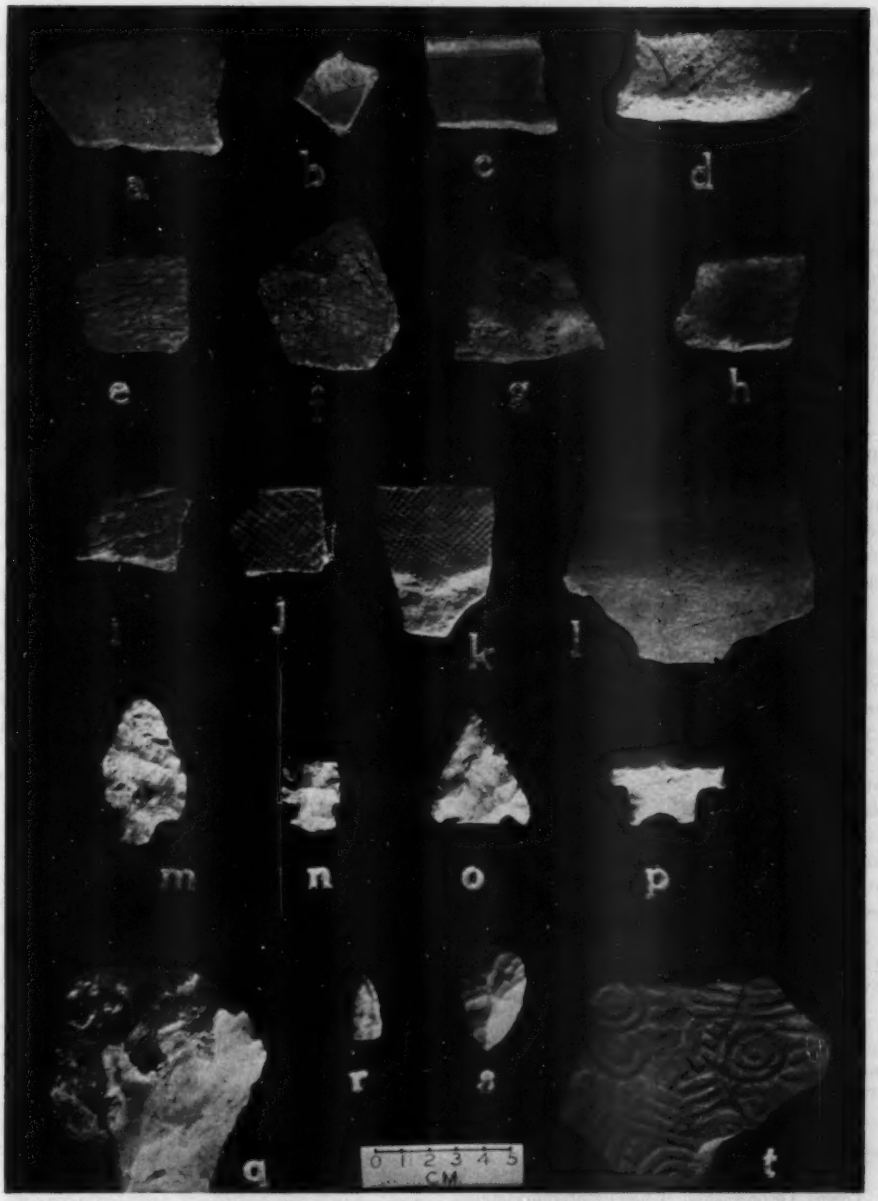


FIG. 10.—Specimens from State Farm site, J-3: *a*, fragment Spanish olive jar; *b*, Mission Red Filmed; *c*, *d*, Ocmulgee Fields Incised; *e*, Chattahoochee Brushed; *f*, cob-marked over Chattahoochee Brushed; *g*, smoothed-over pitted surface; *h*, Plain, Fort Walton paste (red painted interior); *i*, San Marcos Stamped; *j*, *k* Wakulla Check Stamped; *l*, plain, smooth; *m–o*, *r*, projectile points; *p*, hafted scraper; *q*, hoelike tool; *s*, scraper; *t*, Swift Creek Complicated Stamped.

arrow point (Fig. 10, *r*) is late; the others earlier.

Lower Creek(?) Sites

Ten sites, located on uplands, have been designated Lower Creek (?). This does not imply that any of them *necessarily* represent historic Creek villages. All are characterized by a high percentage of Chattahoochee Brushed. In common with the State Farm site (J-3) they produced many "white-slipped" sherds. Of post-Weeden Island sherds from these sites, 35 percent exhibit this color. In contrast with Fort Walton, extremely few sherds (including those listed as Plain, Fort Walton paste) contained mica.

No doubt some of these sites were contemporaneous with the Leon-Jefferson period to the south. Early nineteenth-century English stoneware at many of them suggests the possibility that some may have existed late enough to secure such utensils from traders or early settlers.

At all ten sites material, listed in Table 3, was collected from cultivated fields. In no case did tests disclose Indian material below the zone of cultivation. It is obvious from the inventories that more than one period is represented at several of these sites.

Three sites J-28, J-29, and J-30, all at Port Jackson[8] may be considered as a unit and may actually be parts of the same site. They are located on land inhabited by Econchatimico, an Indian chief, and his people around 1823. The tool listed for J-28 is a keeled end and side scraper, 3 inches long.

A settlement at this location is included in a list of Seminole towns in 1821 as follows (Swanton, 1922, p. 407):

> Tock-to-eth-la, west of Fort Scott and Chattahouchy, ten miles above the fork; forty or fifty warriors were raised at the O-cun-cha-ta, or Red Ground, and moved down.

This town is given again in a list dated 1823 (ibid., p. 411):

> (Town) Totoawathla, (Chief) Eheconhatamico, (Situation) west side of Chattahoochee, 10 miles above the forks.

Following the river, Port Jackson is 9½ miles northwest of the Forks.

[8] Not to be confused with Lake Jackson, which is near Tallahassee.

In an additional article to the Treaty of Moultrie Creek, signed September 18, 1823, certain chiefs were allowed to maintain their establishments even though they were not located on land assigned by the treaty to Indian use. Econchatimico's land was set off as follows:

> For Econchatimico, a reservation commencing on the Chattahoochee, one mile below Econchatimico's house, thence up said river four miles, thence one mile west, thence southerly to a point one mile west of the beginning, thence east to the beginning point.

The article closes with "the number of men retained by the chiefs who have reservations made them at their respective villages." In the list Econchatimico claimed 38 men (Williams, 1837, pp. 282–286).

Econchatimico's land is shown on an Indian Land Cession map to have extended northward from a little below Butler (Royce, 1899, map 14, insert 185). W. S. Pope, Sr., of Sneads, 86 years old in 1949, advised the writer that his grandfather, William S. Pope, the first settler of Sneads, arrived there in 1823 and entertained Econchatimico at dinner on various occasions. Mr. Pope and his sister, while not certain, think Econchatimico's house was at Port Jackson.

At Port Jackson high land near the river is rather large in area and the soil a good sandy loam. It would seem to be the most likely location in the vicinity and I am inclined to believe Econchatimico's home was at Port Jackson as suggested by Mr. Pope.

We do not know when Econchatimico moved to this area but history gives us a clue. In the spring of 1818, McIntosh with a force of Creeks marched down the west bank of the Chattahoochee. On the way they surprised the Indian village of Hitchetaw (in Alabama) "commanded by the Redground King, Econchatti Mico." He escaped but 56 men, 180 women and children, and a quantity of cattle were taken (Williams, 1837, p. 180). On March 10, 1836, Econchatimico was raided again, this time at Port Jackson and by whites, and 20 of his slaves, valued at $12,000–15,000, were stolen (*ibid.*, p. 273; Brevard, 1924, pp. 278–279; House Document 271, pp. 24–39). De Castelnau (1948, p. 205) mentions Econchatimico, then a very old man, in 1838.

Sherds from the three sites at Port Jackson may represent Econchatimico's village, known to have been in existence from about 1819 to 1838. This is the period of the great popularity of Staffordshire stoneware when vast quantities were exported from England to the United States. This stoneware at Fort Jackson and other Lower Creek(?) sites *may* also have been in use this late. Indians were commonly making pottery in 1778, only 45 years earlier, when Bartram passed near here (Van Doren, 1940, pp. 342, 399, 401).

On the other hand, this area was well peopled by whites and many boats took produce up and down the Chattahoochee and Apalachicola Rivers by 1838 (de Castelnau,

TABLE 3.—MATERIAL FROM 10 LOWER CREEK(?) SITES

Specimens	J-28	J-29	J-30	J-42	J-43	J-46	J-47	J-48	J-49	J-50
Chert:										
Chips	23	2	114	96+	6	60+	28+	32+	33+	41+
Cores	1		2	1			1	1	1	1
Utilized flakes	1		1	5		1	1	2	2	8
Worked fragments				6		4		2	3	5
Tools, see text	1			13		3		2	7	7
Quarts:										
Fragments of pebbles				6	1	2	1			1
Hammerstones				2						
Sandstone:										
Rough slab				1						
Shells:										
Oyster				1						2
Busycon				1						
Pottery:										
Chattahoochee Brushed	4	21(2)	3(2)	33(30)	11(9)	31(22)	25(9)	5(2)	16(10)	16(7)
Alachua Cob Marked	1							1		
Miller Plain	1	2								
Leon Check Stamped				2						
Ocmulgee Fields Incised					1	1				
Fort Walton Incised				3(1)						
Plain, Fort Walton paste	7(1)	11(3)	2	66(21)	25(7)	36(10)	22(8)	25(5)	21	22(11)
Notched rims, Fort Walton paste						3	2(2)			
Miscellaneous:										
Plain smooth		9				4			7	
Stamped	7									
Incised				1	2	1		1	1(1)	
Roughened surface				1	1				2	
Handle				1				1		
Wakulla Check Stamped				7				23		
Weeden Island Plain								2		
Weeden Island Red								1		
Smooth Plain								10		
Swift Creek Complicated Stamped						8				1
Crooked River Complicated Stamped				1						
West Florida Cord Marked				2			1			1
Gulf Check Stamped				11		4	2			1
Deptford Simple Stamped				3		1				
Deptford Bold Check Stamped (tetrapod)				1						
Deptford Lineal Check Stamped				5						
Combination ditto and incised lines				2						
Indistinct stamped				13					1	
Plain, sand-tempered				16		21	3	52	7	10
Plain, fiber-tempered				1						
TOTAL SHERDS	20	43	5	169	40	110	55	121	85	51
English stoneware, early nineteenth century	4	5	1	40	1		2	3	3	

1948, p. 208). This English stoneware may, therefore, have belonged to early settlers. If so, they only broke the more common types (blue-edged plates, etc.). Sherds from "collector's items" or from the middle of the nineteenth century were not found.

Specimens from J-42 are illustrated in Fig. 11. This site was probably occupied earlier than any other located by the survey. It is the only one at which a fiber-tempered sherd or any appreciable amount of Deptford pottery was found. It was occupied from Deptford into early Santa Rosa–Swift Creek as well as in Lower Creek(?) times. Leon Check Stamped sherds indicate communication during the latter occupation with Leon-Jefferson—Spanish Mission people to the south. Sherds of Fort Walton Incised are, presumedly, coeval or slightly earlier in date.

Close agreement between pottery of the Lower Creek(?) component of this site with that secured at Port Jackson is evident from the foregoing tabulation. Horizontal distribution of English stoneware agreed with that of Indian pottery. Chips and stone specimens covered a larger area.

Stone specimens, believed to belong to a Deptford occupation, include seven large stemmed points, one small and two large end scrapers, all of chert, a stone disk or pitted hammerstone of quartzite (Fig. 11, *m–u*, respectively) and a rough slab of limestone. One of the projectile points, after being broken, was reworked into a scraper (Fig. 11, *r*).

The inventory from J-43 agrees well with that from the sites at Port Jackson. It should be noticed that neither stone specimens nor early pottery was found.

J-46 had a previous Santa Rosa–Swift Creek occupation. All 24 sherds from that period are eroded while those of the Lower Creek (?) period are not eroded. Stone specimens include a patinated, rough, thick, trianguloid blade; part of an unpatinated, long, trianguloid point with concave base; and a chipped hoelike implement.

A few Santa Rosa–Swift Creek sherds were found at J-47 site. Again the early sherds are eroded, the late ones are not.

The earlier occupation at J-48 was late Weeden Island instead of Santa Rosa–Swift Creek. The two stone tools listed in Table 3 consist of a large stemmed knife and a triangular projectile point. The latter is similar in shape but half again as large as the triangular point from the Butler site (Fig. 5, *z*).

Evidence of a second occupation other than Lower Creek(?) was found at J-49 but, unfortunately, the older sherds are not definitive. Lithic specimens include a chipping hammer, a rough thick asymmetric trianguloid blade, a lanceolate-shaped knife, and four thick stemmed projectile points. The latter have fine retouching along the sides of blades. One, having lost its tip, was reworked into a scraper.

Santa Rosa–Swift Creek is suggested for the earlier habitation at J-50 by the meager inventory of that period available. As before, the Lower Creek(?) period is evidenced by Chattahoochee Brushed and "white slipped" pottery.

Seven stone specimens include three large stemmed projectile points, of which one has been reworked into a scraper. One long and two medium sized projectile points with side notches similar to those from the Tan Vat site (Fig. 4, *q*) were found. A triangular arrow point, duplicating the similarly shaped one from the Butler site (Fig. 5, *z*), completes the lithic inventory.

CONCLUSIONS

We have no information pertaining to man in the lower Chattahoochee Valley prior to Deptford times, circa A. D. 500. This period is represented by an appreciable number of sherds at only one site (J-42). Generalizations concerning life during a Deptford period do not seem warranted.

For Santa Rosa–Swift Creek we have much more data. Six sites or components of that period are located, as will be noted from the map, either on bottom land removed from the present river channel or on high ridges near small streams or the river. Twelve components of the succeeding Weeden Island horizon are similarly located. The Chattahoochee has undoubtedly run in various channels. Bottomland sites may have been adjacent to the river when inhabited.

FIG. 11.—Specimens from Neal site, J-42: *a*, Leon Check Stamped; *b–d*, Chattahoochee Brushed; *e*, Fort Walton Incised; *f*, Wakulla Check Stamped; *g*, West Florida Cord Marked; *h*, combination Deptford Linear Check Stamped and incised; *i*, Deptford Linear Check Stamped; *j*, Gulf Check Stamped; *k*, Deptford Simple Stamped; *l*, Deptford Bold Check Stamped on tetrapod; *m–q*, projectile points; *r*, hafted scraper made from broken point; *s*, *t*, scrapers; *u*, hammerstone, slightly pitted.

The relatively large number of stone specimens from these sites shows a major dependence on hunting but does not indicate a lack of agriculture. In Weeden Island times fresh water shellfish and snails were collected to supplement other food. Sites are small and have a general north-south distribution. This fits a picture of small villages of hunters and collectors of food who were developing into farmers.

Changes in hunting techniques are suggested by changes in projectile points. Deptford and early Santa Rosa–Swift Creek hunters used fairly large and thick stemmed points which frequently had serrated edges. These were probably hafted on spears and propelled by atlatls or spear-throwers. In the latter part of the Santa Rosa–Swift Creek period some points, as evidenced by those from the Tan Vat site (J-18), were smaller and side-notched. These and broad points with deep corner notches, here tentatively correlated with Weeden Island I (site J-31), may have been used with either atlatl or bow and arrow. By Weeden Island II the bow and arrow were well known. Points from the Butler site (J-17) of this period indicate various methods of attachment but are all small in size. Very likely older forms were used contemporaneously with newer ones during these periods.

A distinct cultural shift occurs with the Fort Walton period. Sites (nine) are exclusively located along the present riverbank. Stone tools were of very minor importance and ceramic arts substantially modified. While venison was still enjoyed and shellfish occasionally collected, agriculture had become the basis of the economy. Rich, sand-silt, flood plains attracted people away from the relatively poor farm land of the uplands. At Chattahoochee Landing large flat-topped mounds were constructed as foundations for buildings. Although not demonstrable for the lower Chattahoochee, narrow triangular arrow points are known to have been in use elsewhere during this period.

Farming communities, scattered along river banks and radiating out from a civic and ceremonial center at Chattahoochee Landing, probably formed the social organization of that time.

These radical changes are believed to be the result of influences and people expanding from the Mississippi Valley. The presence in large quantities of Wakulla Check Stamped pottery, typical of the preceding period, indicates that the population of the valley was not entirely displaced by new people.

Another geographical shift occurs with the end of Fort Walton. Presence of Chattahoochee Brushed and Alachua Cob Marked pottery at the Jim Woodruff (J-2) and at J-23 sites, both of the Fort Walton period, demonstrate them not to have been abandoned before the impact of new influences from outside the lower Chattahoochee Valley. These influences may have had a more impelling force than floods in causing abandonment of levee sites.

Along the Gulf coast about half of the Fort Walton sites have produced articles of European manufacture. For this reason end of Fort Walton has been arbitrarily set as circa 1650. This date is merely an estimate and might be as much as 50 or more years off, either way. It is also quite possible that people continued living with a Fort Walton culture later in the lower Chattahoochee Valley than they did on the Gulf coast.

Spanish missions, at which there were domesticated animals, were started across north Florida in 1633 and virtually wiped out by Governor Moore of South Carolina in 1704 (Boyd, 1939, p. 255). Adair says horses and hogs were common in Indian towns to the north of Chattahoochee in 1740–1760 (Williams, 1930, pp. 290, 390, 436, 444). Bartram's Travels contain many references to Indians having horses, cattle, hogs, and Negro slaves in 1777 (Van Doren, 1940, pp. 350–351). In 1718 Indians living near St. Augustine and St. Marks had horses, cattle, and hogs (Williams, 1837, p. 180).

The end of Fort Walton times is not too far removed from dates when Indians are known to have had domesticated animals. Need of more area to exploit this new source of food and a lessened dependence on *rich* farmland may have resulted in the abandonment of Fort Walton sites along the lower Chattahoochee. Concomitant deterioration in ceramic arts would reflect the prestige value of livestock and the attention given to them.

Post-Fort Walton sites in the lower Chattahoochee Valley fall into two groups. Leon-

Jefferson sites, near Sneads, are oriented, at least in their ceramics, toward the Spanish missions around Tallahassee to the southeast. The other group, consisting of nine Lower Creek(?) sites, are characterized by Chattahoochee Brushed pottery, which is common in this period in eastern Alabama and western Georgia. They are oriented toward the north. Trade sherds prove these two areal divisions to be in part contemporaneous.

One is tempted to see in these Lower Creek(?) sites evidence of the southern drift of Indians, part of whom, together with other groups, later became Seminoles. Bartram, who crossed the middle Chattahoochee River (in Alabama) in 1777, mentions the Creek town of Apalachula and notes that *old* Apalachula had been abandoned about twenty years before. The greater number from there, he writes, chose to settle new (1777) Apalachula but other bands under auspices of the chief of each family or tribe settled villages lower down the river (Van Doren, 1940, p. 314). The archeological evidence fits well with Bartram's information.

REFERENCES

BOYD, MARK F. *Mission sites in Florida*. Florida Hist. Quart. **17** (4): 254–280. 1939.

BREVARD, CAROLINE MAYS. *A history of Florida*. Florida Historical Society, 1924.

CASTELNAU, COMTE DE. *Essay on Middle Florida* [translated by Seymour]. Florida Hist. Quart. **26** (3): 201–255. 1948.

GRIFFIN, JOHN W. *Prehistoric Florida—a review*. MS.

———. *Test excavations at the Lake Jackson site*. MS.

GOGGIN, JOHN M. *A preliminary definition of archaeological areas and periods in Florida*. Amer. Antiq. **13** (2): 114–127. 1947.

———. *Some pottery types from central Florida*. Bull. Gainesville Anthrop. Assoc. no. 1. 1948a.

———. *A revised temporal chart of Florida archaeology*. Florida Anthrop. **1** (3–4): 57–60. 1948b.

HURT, WESLEY R., JR. *Archaeological survey, Chattahoochee Valley, Alabama*. MS.

MOORE, CLARENCE B. *Mounds of the Lower Chattahoochee and Lower Flint Rivers*. Journ. Acad. Nat. Sci. Philadelphia **13**: 426–456. 1907.

ROYCE, C. C. *Indian land cessions in the United States*. 18th Ann. Rep. Bur. Amer. Ethnol., pt. 2. 1899.

SMITH, HALE G. *Two historical archaeological periods in Florida*. Amer. Antiq. **13** (4): 313–319. 1948.

SWANTON, JOHN R. *Early history of the Creek Indians and their neighbors*. Bur. Amer. Ethnol. Bull. 73. 1922.

UNITED STATES CONGRESS. *Message from President Jackson respecting causes of the Seminole hostilities*. (Containing letters from Wiley Thompson, agent for Florida Indians, to William P. Duval, Superintendent of Indian Affairs.) House Doc. 271, 24th Congr., 1st sess. 1836.

VAN DOREN, MARK [editor]. *The travels of William Bartram*. New York, 1940.

WENHOLD, LUCY L. *A 17th century letter of Gabriel Diaz Vara Calderón, Bishop of Cuba, describing the Indians and Indian missions of Florida*. Smithsonian Misc. Coll. **95** (16). 1936.

WILLEY, GORDON R. *The Weeden Island culture: A preliminary definition*. Amer. Antiq. **10** (3): 225–254. 1945.

———. *Culture sequence in the Manatee region of west Florida*. Amer. Antiq. **13** (3): 209–218. 1948.

———. *Archeology of the Florida Gulf coast*. Smithsonian Misc. Coll. **113**: 599 pp., 76 figs., 20 maps, 60 pls. 1949.

——— AND WOODBURY, R. B. *A chronological outline for the northwest Florida coast*. Amer. Antiq. **7** (3): 313–319. 1942.

WILLIAMS, JOHN REE. *The Territory of Florida: or Sketches of the topography, civil and natural history of the country, the climate, and the Indians from the first discovery to the present time*. New York, 1837.

WILLIAMS, SAMUEL C. *Adair's History of the American Indian*. Johnson City, Tenn., 1930.

ENTOMOLOGY.—*A new genus and species of trombiculid mite (Acarina).*[1]

ROBERT TRAUB, Major, MSC, and THOMAS M. EVANS, Army Medical Department Research and Graduate School, Washington, D. C. (Communicated by ALAN STONE.)

Among the trombiculid mites collected by the United States of America Typhus Commission in Assam and Burma in 1944–45 is a remarkable new genus of the subfamily Trombiculinae Ewing, collected from a bird.

Mackiena, n. gen.

Agrees with *Riedlinia* Oudemans 1914 in that middle claw is represented by a swollen empodium—the only trombiculid mites in which this condition is known to occur. Separated from *Riedlinia* in that the empodium is pulvilliform, not lanceolate or spatulate; in that the eyes are well developed, not absent; in that the dorsum and venter are covered with a series of fine, definite, concentric circular striations resembling whorls of fingerprints; the palpal claw is trifurcate, not bifurcate; segment II of palpus lacks a lateral tubercle and is devoid of setae (*Riedlinia* bears both a lateral tubercle and a seta); the palpal genu bears a frayed seta, not a nude one; the galea seta is plumed, not nude.

Agrees with *Euschöngastia* Ewing 1938, in that the scutum or dorsal plate bears a single anteromedian bristle, a pair of posterolateral bristles, a pair of anterolateral bristles, and the sensillae are clavate-globose; the chelicerae nonserrate, with a single subapical notch.

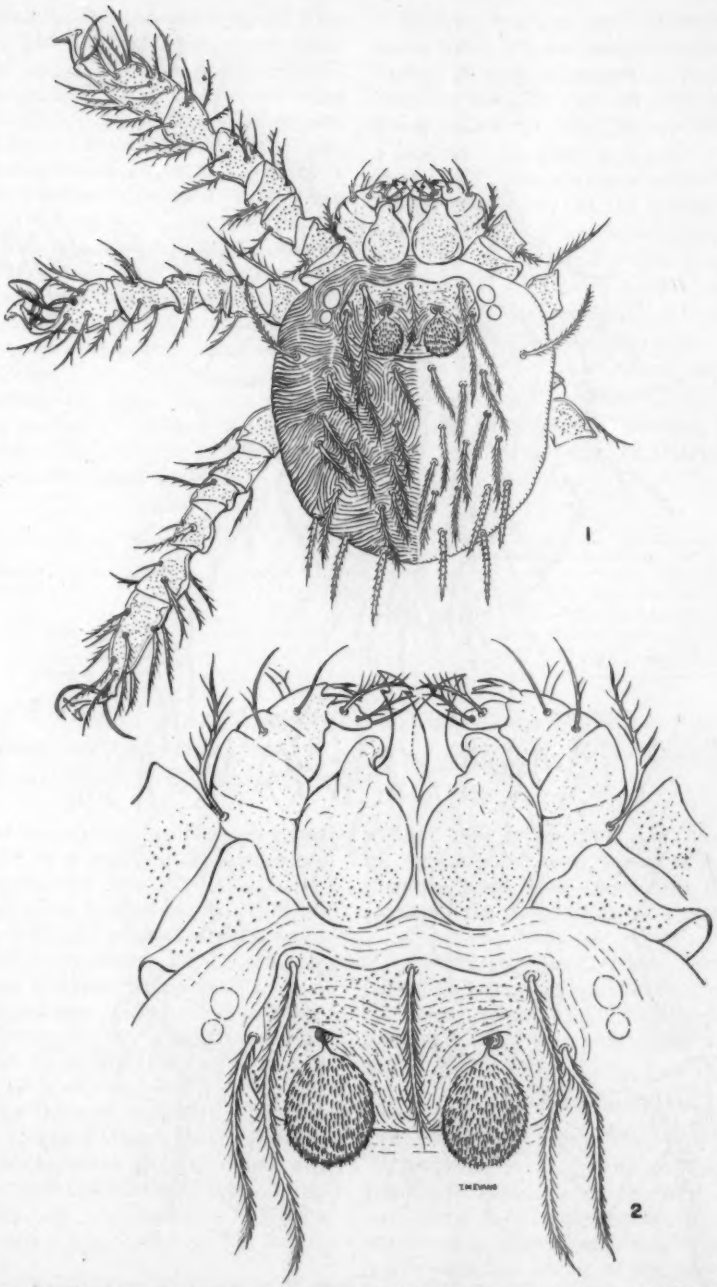
With an indication of a crest immediately anterior to the bases of the pseudostigmatic organs. Anterior portion of dorsal plate finely punctate; caudal portion distinctly whorled, with concentric striations. Coxae unisetose. With four ventral setae between coxae III.

Genotype: *Mackiena empodiformia,* n. sp.; no other species known.

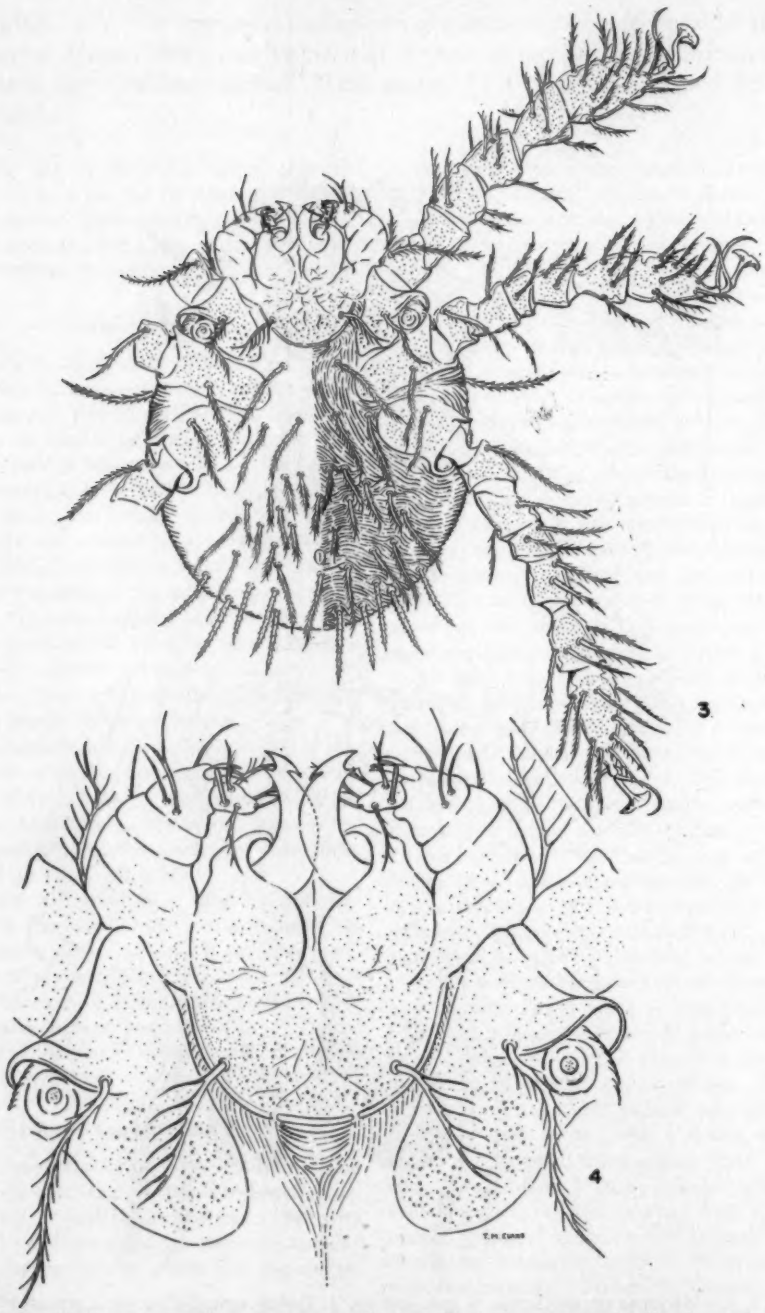
Mackiena empodiformia, n. sp.

Larval description (Figs. 1–4).—BODY: Outline ovate-subcircular, slightly angulate laterally between coxae II and III; dorsum and venter covered with well developed, concentric circular striations in the form of whorls like fingerprints or contour lines on a map; length 0.23 mm, width 0.185 mm. DORSAL PLATE: Anterior margin slightly sinuate, with one median and two lateral lobes; lateral margins evenly rounded, convex; ratio of length to width: 9 to 13; punctate over most of surface, especially anterior portion, but punctations extending into whorled area; whorls extending cephalad to bases of sensillae (pseudostigmatic organs); with a darkened sinuate ridge extending anterior to and mesad of bases of sensillae, the sinus deepest mesad of bases. Sensillae clavate-globose, petiole extremely short; tomentose; distal fourth of pseudostigmatic organ extending beyond posterior margin of dorsal plate. Bases of pseudostigmatic organs inserted on al ine minutely cephalad of bases of posterolateral setae. Anterolateral setae long and narrow; slightly more than twice the length of dorsal plate; plumose but with short cilia. Anteromedian bristle same diameter as anterolateral, but only slightly longer than dorsal plate; inserted in line with anterolaterals; plumose but with short cilia. Posterolateral setae inserted at level of midline of dorsal plate; similar to anterolaterals but only three-fourths the length. EYES: Well developed; contiguous to dorsal plate laterad of bases of dorsolateral setae; cephalic eye with slightly greater diameter than caudal eye; combined length 24.5μ; width of cephalic eye 12μ. CHELICERAE: Acuminate, about 5 times as long as wide near base; with a single subapical notch on each side. PALPAL CLAW: Trifurcate, lateral prongs about three-fourths length of middle prong. PALPAL TARSUS: Almost twice as long as broad at base; with two dorsal branched setae, an apical smooth seta, two ventral plumed setae and a proximal ventral short spurlike process. PALPUS: With a proximal dorsal plumed seta on palpal trochanter and femur; with a dorsal, sparsely frayed seta on genu; 1 fine seta on dorsal surface and 1 frayed and 1 entire smaller bristle on ventral surface of tibia. GALEA: With a pair of plumed proximal ventral setae. DORSAL SETAE: Similar to dorsolaterals, about 30 in number, with rows arranged 2-6-4-6-(?). COXAE: Unisetose, setae plumose; coxa I with a dorsal thumblike extension at caudolateral angle, dorsad to well-developed stigma. STERNAL SETAE: A pair of plumose setae between bases of coxae I and

[1] Published under the auspices of the Surgeon General, U. S. Army, who does not necessarily assume responsibility for the professional opinions expressed by the authors. Received December 22, 1949.



FIGS. 1, 2.—*Mackiena empodiformia*, n. gen. and sp.: 1, Dorsal aspect of larva; 2, details of anterior region.



FIGS. 3, 4.—*Mackiena empodiformia*, n. gen. and sp.: 3, Ventral aspect; 4, details of anterior region.

II, and two similar pair between coxae III. VENTRAL SETAE: About 36 thin frayed setae in horseshoe shaped rows of 10-8-8-(?), the sinus of each row facing caudad; the more posterior setae somewhat longer and stouter than more anterior. LEGS: I—0.26 mm; II—0.25 mm; III—0.27 mm. Sensory setae as follows: I—1 spur, 2 genualae, 1 microtibiala, 1 subterminala, 1 microspur, 1 microgenuala, 2 tibialae. II—1 spur, 1 genuala, 2 tibialae. III—1 genuala and 1 tibiala. TARSAL CLAWS: Outer claws elongate, acuminate, curved, resembling the blade of a scythe; proximal portion of empodium subequal to diameter of claw, expanded portion of empodium about 4–5 times diameter of claw.

Type material.—Holotype (U. S. A. Typhus Commission no. 718-1) deposited in U. S. National Museum. One paratype in collection of British Museum of Natural History.

Records.—Holotype and paratype from a weaver-finch (*Ploceus manyar peguensis* Stuart Baker); 20 miles northwest of Myitkyina, on Mogaung Road, February 23, 1945, collected by United States of America Typhus Commission.

Remarks.—The genus is named for Col. T. T. Mackie, M.C., who was in command of the India-Burma Field Party of the United States of America Typhus Commission. Capt. Roy T. Melvin of that organization first recognized the generic status. I am deeply indebted to Dr. H. S. Fuller, of the Harvard School of Public Health, who examined *Riedlinia coeca* in the Oudemans collection and who kindly allowed me to use his notes concerning this species. Dr. G. W. Wharton, of the Department of Zoology, Duke University, was instrumental in transmitting Dr. Fuller's notes to me.

STANDARD MEASUREMENTS

Slide No.	AW	PW	SB	ASB	PSB	A-P	AM	AL	PL	SENS	DS
718-1 (holotype)	56	76	37	21	21	19	46	84	66	30	56
718-2 (paratype)	57	78	38	—	—	—	42	84	67	—	63
Mean	56	77	38	21	21	19	44	84	67	30	60

ZOOLOGY.—*A new copepod,* Pseudanthessius latus *(Cyclopoida: Lichomolgidae), commensal with a marine flatworm.*[1]

PAUL L. ILLG, U. S. National Museum
(Communicated by FENNER A. CHACE, Jr.)

For some years there has been on record the existence of a copepod ectocommensal of very large marine flatworms found on the Pacific coast of the United States. Identified by Wilson, 1935, as *Pseudanthessius obscurus* Scott, several specimens have been preserved in the National Museum. Since that date additional specimens have been added to the collection by the original collectors, Mr. and Mrs. G. E. MacGinitie. Other specimens have been seen and collected from Puget Sound by the author and by Dr. Frank A. Pitelka. Detailed study of the specimens available demonstrates them to represent a new species, well differentiated from the remaining members of the genus. Nicholls, 1944, provided a key to the species known to that date and pointed out the necessity for exclusion of some incorrectly assigned species. Since this treatment there has appeared the descriptions of 2 new species, *P. gracilioides* Seymour Sewell, 1949, and *P. spinifer* Lindberg, 1946. Accordingly, Nicholls's key, with modification to provide for the 3 subsequently found species, is presented below as a concise differentiation of the various forms.

[1] Published by permission of the Secretary of the Smithsonian Institution. Received December 2, 1949.

Family LICHOMOLGIDAE Claus, 1889

Pseudanthessius Claus, 1889; Nicholls, 1944

The genus is very close to *Lichomolgus*. The salient differentiating character is the reduced fifth foot, consisting of only a spine and two setae, originating directly from the body proper, all other vestige of the appendage as free outgrowth having been completely suppressed.

KEY TO SPECIES OF PSEUDANTHESSIUS

[Modified after Nicholls, 1944]

1. Outer margin of fourth endopodite entire, simply convex.....2
   Outer margin of fourth endopodite sinuate, broken by a swelling or indentation which may become a conspicuous knob or notch...4
2. Lateral margins of genital segment produced into conspicuous expansions
   spinifer Lindberg, 1946
   Lateral margins of genital segment not conspicuously expanded.....3
3. Caudal rami twice as long as wide, little longer than anal segment
   liber (Brady and Robertson, 1875)
   Caudal rami three times as long as wide, one-third as long again as anal segment
   assimilis Sars, 1917
4. Greatest width of fourth endopodite over one-half length.....*latus*, n. sp.
   Greatest width of fourth endopodite less than one-half length.....5
5. Caudal rami twice as long as wide
   sauvagei Canu, 1891
   Caudal rami more than twice but not more than four times as long as wide.....6
   Caudal rami more than four times but not more than seven times as long as wide.....8
   Caudal rami at least 10 times as long as wide 9
6. Fourth endopodite with marked notch at proximal third; segments of first antenna short and compact; genital segment not greatly dilated.....*obscurus* A. Scott, 1909
   Fourth endopodite with notch or constriction at center; segments of first antenna normal; genital segment considerably dilated.....7
7. Second thoracic segment with posterior projections; fourth endopodite no longer than basal segment of exopodite, with proximal bulge but no notch.*mucronatus* Gurney, 1927
   Second thoracic segment without posterior projections; fourth endopodite longer than basal segment of exopod and with a distinct notch.....*tenuis* Nicholls, 1944
8. Fourth endopodite with marked notch at about center; less than four times as long as wide.....*gracilis* Claus, 1889
   Fourth endopodite with notch at center; more than five times as long as wide
   gracilioides Sewell, 1949
   Fourth endopodite with slight notch at center and proximal bulge; caudal rami five times as long as wide.....*weberi* A. Scott, 1909
   Fourth endopodite without notch but with slight proximal bulge; caudal rami four to four and one-half times as long as wide
   nemertophilus Gallien, 1935
9. Last two segments of urosome subequal.....10
   Anal segment at least twice as long as preanal
   thorelli (Brady and Robertson, 1875)
10. Caudal rami about as long as last two segments of urosome together.....*dubius* Sars, 1918
    Caudal rami about as long as last three segments of urosome together
    concinnus Thompson and Scott, 1903

Pseudanthessius latus, n. sp.

Pseudanthessius obscurus C. B. Wilson, 1935, p. 780, pl. 27, fig. 36.

Specimens examined.—12 females, 8 males, all adult; Anaheim Slough, Calif.; surface of large gray flatworm; October 22, 1937; G. E. MacGinitie.

1 female; adult; San Juan Island, Wash.; surface of large flatworm; July, 1939; Paul L. Illg.

6 females, one male, all adult; Santa Ana River, Calif.; backs of large flatworms; December 11, 1932; G. E. MacGinitie. (Recorded as *P. obscurus* Scott, Wilson, 1935.)

9 females, adult; Turn Rock, near San Juan Island, Wash.; surface of large flatworms (*Cryptophallus magnus* Freeman); July 2, 1940; F. A. Pitelka.

Types.—Holotypic female, U.S.N.M. no. 90285; allotypic male no. 90286; locality Anaheim Slough, Calif.; scientific name of flatworm host not known. The remainder of the specimens examined are designated paratypes.

Description.—Female (Figs. 1, *a–k*): Body length 1.82 mm. Body form (Fig. 1, *a*) typically lichomolgid but with conspicuous broadening of the metasome, producing an anterior body region of suborbicular outline. There is no rostrum. The thoracic segment bearing the first swimming legs is fused into the cephalothoracic portion of the metasome. The segments of the second to fourth swimming legs are free, that of the second legs much the widest, that of the third legs longer than the others. The segment of the fifth legs is sharply set off both from the metasome and the genital segment. The urosome, including the segment of the fifth legs, is 5-segmented. The genital segment is much dilated anteriorly, thus being considerably wider than long. The three free abdominal segments are subequal in length, each slightly longer than wide. The caudal rami are at least 1½ times as long as the anal segment. The longest seta of each caudal ramus is longer than the combined lengths of the free abdominal segments and rami. The ovisacs are elongate, slender cylinders, carried closely appressed to the abdomen, and, in most cases, slightly exceeding the tips of the caudal rami. The eggs are minute and a rough estimate would indicate there are upwards of 300 eggs in each ovisac. The general body aspect is neat and trim and the proportions achieve a fairly graceful symmetry.

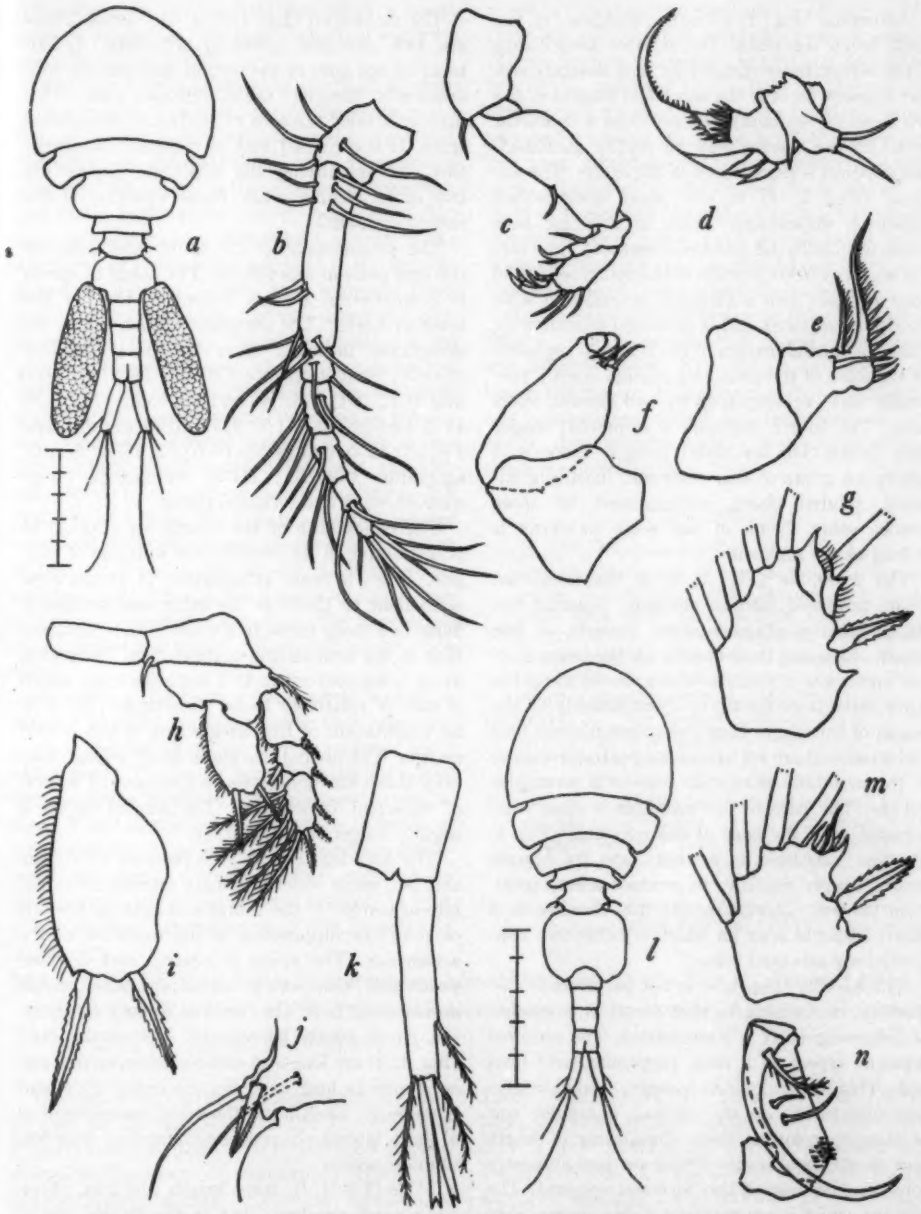


FIG. 1.—*Pseudanthessius latus*, n. sp. Female: *a*, Dorsal view; *b*, antennule; *c*, antenna; *d*, mandible and maxillule in posterior view so that maxillule appears as superimposed upon mandible; *e*, maxilla; *f*, maxilliped; *g*, distal segment of first endopodite; *h*, fourth swimming leg; *i*, fourth endopodite; *j*, fifth leg; *k*, caudal ramus. Male: *l*, Dorsal view; *m*, terminal segment of first endopodite; *n*, maxilliped. The scales referring to dorsal views of male and female represent 0.5 mm.

Antennule (Fig. 1, *b*) rather elongate, of the usual seven segments. The relative proportions of the segments are distinctive. The elongate second segment exceeds the combined lengths of the five terminal segments and provides a character by which the species may be readily identified. The setation is represented in the figure. The antenna (Fig. 1, *c*) is the usual 4-segmented prehensile appendage. There is a single seta borne terminally on the basal segment. The second segment bears a single subterminal seta. The third segment has a diagonal articulation with the fourth segment and is produced considerably along the medial margin of the terminal segment. At the apex of the produced portion is set a prehensile claw, accompanied by two slender, short setae. The fourth segment is somewhat longer than broad. On its distal margin there is a closely set group of four subequal, lineally graduated, jointed claws, accompanied by three slender setae. None of the setae or claws is as long as the segment.

The mandible (Fig. 1, *d*) is the usual flat blade, produced into an elongate, tapering tip. Its distinctive ornamentation consists of two broad, chitinized flaps basally on the outer margin, and a row of spinules which are set along the inner curve from the tip to about midway on the length of the blade. Here the spines become long and stout and are set across the posterior surface of the mandible along two sides of a triangular outline. The base of the mandible is closely associated with the base of the maxillule (Fig. 1, *d*). The maxillule is a thin flap, its margin incised deeply medially to produce a long spiniform process. Terminally the flap narrows to a short, truncate apex on which is borne two relatively long subequal setae.

The maxilla (Fig. 1, *e*) is not particularly distinctive, conforming to that found in a number of lichomolgids. It is 2-segmented. The terminal segment tapers to a long, perpendicularly bent lash. This bears along its margin, medial in normal orientation on the animal, a regular row of elongate spinules, these diminishing in length and stoutness apically. There are two accessory setae on the base of this terminal segment. The shorter, which is unornamented, lies appressed to the surface of the basal portion of the second segment and parallel to the long axis of the basal portion. The second bears a single row of cilia along its medial margin and is set on the anterior edge of the basal part of the segment so that it extends parallel with the lashlike distal extension of the segment.

The maxilliped (Fig. 1, *f*) is very stout. There are two subequal proximal segments. Articulated on the apex of the second segment is a pronouncedly tapered, much reflexed claw. This may be a third segment or simply an articulated spine. It is provided with an extensive musculature. Accompanying the articulated spine are two short, slender setae, borne apically on the second segment.

The arrangement of the spines and setae on the four pairs of legs follows. The count of spines is presented in Roman numerals, that of the setae in Arabic. The segments of each ramus are designated in order from the basal segment distally. First exopodite I-0; I-1; IV-4; endopodite O-1; O-1; I-5. Second exopodite I-0; I-1; IV-5; endopodite O-1; O-2; III-3. Third exopodite I-0; I-1; IV-5; endopodite O-1; O-2; III-2. Fourth exopodite I-0; I-1; III-5; endopodite 1-segmented, with two terminal spines.

The endopodite of the fourth leg (Fig. 1, *h*) is distinctive in its considerable inflation of outline. From a basal articulation of proportions equivalent to those in the other endopodites it flares in a steep curve to a width nearly 2½ times that of the articulating margin, then diminishes along a sigmoid curve to a truncate apex which is still of relatively broad amplitude. There is no indentation of the integument of the lateral margin. The medial margin is finely ciliate. Distally there are borne two well-separated spines, of subequal dimensions. The medial spine is slightly longer than the other.

The fifth leg (Fig. 1, *j*) is reduced to a spine and two setae which originate directly from the lateral margin of the thoracic somite, as a result of complete suppression of the segments of the appendage. The spine is ventral and directed posteriorly. One seta is lateral, the other on the dorsal side; both are directed mainly laterally, but curve gently posteriorly. The caudal rami (Fig. 1, *k*) are long and slender, between five and six times as long as wide, somewhat divergent posteriorly. Each bears the usual complement of a short lateral plumose seta and four terminal plumose setae.

Male (Fig. 1, *l*): body length 1.55 mm. Metasome much slenderer than in the female, but of corresponding segmentation. The somite of the fifth swimming legs is more elongate than that of the female but equally markedly delimited from the adjoining segments. The urosome consists of six segments. The first abdominal segment is considerably enveloped anteriorly by the genital somite. The genital segment is laterally

expanded to a subquadrate outline. The width exceeds the length. The four abdominal segments are subequal in length.

The appendages conform in the main to those of the female. The usual dimorphism characteristic of the lichomolgids is exhibited in the transformation of the maxilliped into a prehensile structure (Fig. 1, *n*), in the presence of sixth legs, and in the segmentation of the urosome. A further manifestation of dimorphism is seen in the alteration of the terminal segment of the first endopodite. In the female this segment bears a short lateral spine and five well-developed, plumose setae (Fig. 1, *g*). The male condition is the result of the suppression of the most lateral of the setae (Fig. 1, *m*). Here there are only four normally developed setae. The shape of the entire segment is altered somewhat and at the point which would normally support the fifth seta there are several spinose projections of the integument among which stands a short, slender wisp, which may represent an extreme reduction of the seta found in the female. A similar tendency to dimorphism in the swimming legs occurs in other lichomolgids and may offer a prospect of convenient specific differentiation in some cases.

Remarks.—The host of the present species, a marine polyclad (possibly more than one species), is an addition to the diverse roster of hosts of the genus. Previously recorded associates have been annelids, mollusks, echinoids, and a nemertean. Many of the records of the occurrence of species of the genus have been based on planktonic samplings. Continued free existence of these individuals would be most unlikely in view of the extreme specialization of the mouthparts which are unsuited to the capture of any motile organism and probably incapable even of seizure of free-floating particles. A varying degree of tenacity in adhering to the host on the part of these copepods must explain the relatively large number of species for which no host record has yet been established. In the present instance most specimens so far found have shown a marked inclination to adhere to the surface of the worm and many have so remained after hours of tumbling about in the diverse lot of materials obtained from several dredge hauls.

The specific differentiation of *Pseudanthessius latus* is readily established on characters consistent in both sexes. The fourth endopodite is highly distinctive, as is the elongation of the second antennular segment and both features are readily determinable under a low degree of microscopic magnification.

REFERENCES

CLAUS, C. *Über neue oder wenig bekannte halbparasitische Copepoden, insbesondere die Lichomolgiden- und Ascomyzontiden-Gruppe.* Arb. Zool. Inst. Wien. **8** (3): 327–370, 7 pls. 1889.

NICHOLLS, A. G. *Littoral Copepoda from South Australia (II): Calanoida, Cyclopoida, Notodelphyoida, Monstrilloida and Caligoida.* Rec. South Australian Mus. **8**: 1–62, 28 figs. 1944.

LINDBERG, K. *Un nouveau copepode poecilostome de l'Inde de la famille des Lichomolgidae:* Pseudanthessius spinifer, *n. sp.* Bull. Soc. Zool. France **70**: 81–84, 13 figs. 1946.

SEWELL, R. B. SEYMOUR. *The littoral and semiparasitic Cyclopoida, the Monstrilloida and Notodelphyoida.* John Murray Expedition, 1933–34, Scientific Reports, **9** (2): 17–199 41 figs. 1949.

WILSON, C. B. *Parasitic copepods from the Pacific coast.* Amer. Midl. Nat. **16**: 776–797, 6 pls. 1935.

MAMMALOGY.—*Notes on microtine rodents from the Brooks Range, Arctic Alaska.*[1]

ROBERT RAUSCH, U. S. Public Health Service, Anchorage, Alaska. (Communicated by DAVID H. JOHNSON.)

In connection with parasitological studies carried on during 1949 for the U. S. Public Health Service, the writer collected a considerable number of mammals from the northern edge of the "Endicott" section of the Brooks Range, in Arctic Alaska. The mammalian fauna of this region is poorly known, since apparently no previous collecting has been done here. About 200 microtine rodents were collected, mostly near Tolugak Lake (lat. 68° 24′ N., long. 151° 26′ W.), near the head of the Anaktuvuk River Valley. A few specimens were also taken at Umiat, on the Colville River, about 80 miles north of Tolugak Lake (lat. 69° 23′ N., long. 152° 10′ W.). Five species are represented. More complete details concerning their ecology and reproduction will be presented in a later paper, at which time the other mammals obtained will also be considered. The specimens have been deposited in the U. S. National Museum.

[1] Received January 18, 1950.

The writer wishes to express appreciation of the kind cooperation of Drs. Remington Kellogg, David H. Johnson, and Henry W. Setzer in making available working space and facilities at the U. S. National Museum, and of their helpful suggestions.

Clethrionomys rutilus dawsoni (Merriam)

Red-backed voles were collected at the northern edge of the Brooks Range, at altitudes from 2,000 to 3,500 feet, and at Umiat, at the edge of the Arctic Coastal Plain, at altitudes from 300 to 500 feet.

In connection with the identification of the species of Brooks Range *Clethrionomys*, it seemed advisable to study all available material in order to reach some conclusion as to the actual species involved. The rather extensive material from both Eurasia and North America in the collections of the U. S. National Museum was utilized in making this study, with the conclusion that the Nearctic *C. dawsoni* (Merriam) is conspecific with the Palearctic *C. rutilus* Pallas.

A series of more than 20 specimens of *Clethrionomys* was obtained near Tolugak Lake, and 5 others were collected at Umiat. In addition, 24 specimens from northern Alaska, in the U. S. National Museum collection, were compared in detail with Eurasian material. Of the latter, 92 specimens of *C. rutilus jochelsoni* Allen were studied, along with smaller series of *C. rutilus rutilus* Pallas, *C. rutilus russatus* Radde, and *C. rutilus hintoni* Vinogradov. The distribution of the Siberian species of *Clethrionomys* was shown by Bobrinskoy, Kuznetzov, and Kuzyakin (1944, map no. 55). *Clethrionomys r. jochelsoni*, decribed from Verkhne Kolymsk, Kolyma River, northeastern Siberia, is the form most closely related to that found in Alaska.

The Alaskan specimens were closely compared with the large series of *C. rutilus jochelsoni* and were found to be very similar. Cranially, the Alaskan material shows a slightly heavier and longer rostrum, although this character is somewhat variable in both series. The nasal bones are longer in the Alaskan material. Some of the Alaskan specimens show a slightly greater arching of the cranium than is seen in the Siberian specimens. The zygomata are variable in both series; some show an anterior narrowing, some a posterior narrowing, and in some the zygomatic width is the same throughout. The molar pattern, though somewhat variable, is very nearly identical in the two series. A summary of cranial measurements is given in Table 1.

Externally the Alaskan specimens from Tolugak Lake are hardly distinguishable from specimens from northern Siberia (Kolyma River). The Tolugak Lake specimens show a dark-rufous dorsal color, which becomes lighter and more tawny on the sides. The sides show a rather olive tinge during the spring and summer but become much more tawny and the dorsal color becomes brighter in the winter pelage, when fewer interspersed dark hairs are present. Ventrally the Alaskan specimens range from grayish to buffy. In winter pelage the tail is very hairy and is rufous above and buffy below. The specimens from Tolugak Lake and Umiat are considerably darker in color than those from farther south in Alaska (Chignik, on the Alaskan Peninsula, and Charlie Creek, near the Alaska-Yukon boundary). The specimens from the southern localities show a more yellowish cast throughout, and in dorsal coloration the Chignik specimens are indistinguishable from specimens of *C. r. jochelsoni* from the Lesser Annui River, Siberia. The latter are more yellowish below, however. Certain of the Siberian specimens of *C. r. jochelsoni*, from Nijni Kolimsk, show less dorsal rufous coloring.

A small series of specimens of *C. r. rutilus* from Tandy, oriental Siberia, is very similar to the northern Alaskan specimens, having also grayish underparts. Specimens from Lappmark, Sweden, show more tawny coloration, being very similar to the Alaskan specimens from Chignik. The animals from Dapucha, in the Altai, central Siberia, show a tendency toward grayness when compared with northern Siberian and with Alaskan specimens.

C. rutilus hintoni, from the Eimanachi River, Greater Kingham Mountains, northern Manchuria, shows a general paleness of color when compared with northern Siberian and Alaskan specimens. There is less tendency toward tawniness, and the underparts are whitish without any buffy tinge.

It has long been recognized that the north Alaskan species of *Clethrionomys* (*C. dawsoni* auct.) is very closely related to the Palearctic *C. rutilus*. Bailey (1897), speaking of the genus *Evotomys* (= *Clethrionomys*), stated: "The only circumpolar species is the Arctic *E. rutilus*, which does not undergo any considerable change throughout the circumference of the Arctic Zone," and further, that "boreal species are far more stable and persistent than those inhabiting

warmer countries. In view of this fact, it is not surprising that the circumpolar *E. rutilus* presents but one phase throughout its entire range (specimens from Scandinavia, Siberia, and Arctic America being practically indistinguishable)." Zimmermann (1942), in regard to *C. rutilus*, stated that "Unter den europäischen kleinsäugern ist *M. oeconomus* nicht der einzige, der zur Zeit mit Unrecht als palearktisch gilt. Soweit ich aus eigener Anschauung sehe, haben die Rötelmäuse (*Cl. rutilus*, vielleicht auch *glareolus*), . . . ebenso ihre amerikanischen Unterarten, nur sind diese Zusammenhänge zur Zeit durch nomenklatorische Schwierigkeiten verschleiert." Recent American workers have considered *C. dawsoni* to be specifically distinct from *C. rutilus*. In his study of the *C. dawsoni* group, Orr (1945, p. 69) pointed out the similarities of the two forms, but his material was apparently inadequate to allow the comparisons necessary to better understand the relationships involved.

In the opinion of the writer, there is no further justification to consider *Clethrionomys dawsoni* as having full specific rank, since all differences from *C. rutilus* are so slight as to be subspecific in nature. The American races should stand as follows:

Clethrionomys rutilus dawsoni (Merriam)
Clethrionomys rutilus glacialis Orr
Clethrionomys rutilus insularis (Heller)
Clethrionomys rutilus orca (Merriam)
Clethrionomys rutilus watsoni Orr

Microtus oeconomus macfarlani Merriam

Tundra voles were trapped rather commonly in certain habitats, usually in wet tundra areas, at altitudes up to 2,000 feet. They were never so abundant, where observations were made, as was *Microtus miurus*. *Microtus oeconomus macfarlani* was collected both at Tolugak Lake and at Umiat; it probably occurs in all suitable habitat in this region. In general, the summer specimens were darker in color than is considered typical for this subspecies. Two subadult specimens, collected during early June, showed a peculiar buffy color dorsally—apparently a characteristic of the winter pelage, since molting was in evidence. They were cranially identical with the present species. A total of more than 30 specimens was obtained.

According to the work of Zimmermann (1942), with which the writer agrees after having examined pertinent material, the Alaskan *Microtus operarius* is conspecific with *M. oeconomus* of Eurasia. Gilmore (1946) regarded *M. operarius* as conspecific with *M. kamtschaticus* of Siberia; however, according to Zimmermann, *kamtschaticus* is a subspecies of *M. oeconomus*. Several subspecies were previously assigned to the Alaskan *M. operarius;* of these, according to Anderson (1937), *M. operarius endoecus* is identical with *M. o. macfarlani*, the latter name having priority. With this one change, Zimmermann's classification of the *Microtus oeconomus* group of Alaskan voles is as follows:

Microtus oeconomus operarius Nelson
Microtus oeconomus macfarlani Merriam (syn. *endoecus* Osgood)
Microtus oeconomus yakutatensis Merriam
Microtus oeconomus kadiacensis Merriam
Microtus oeconomus unalascensis Merriam
Microtus oeconomus popofensis Merriam
Microtus oeconomus sitkensis Merriam
Microtus oeconomus innuitus Merriam
Microtus oeconomus punukensis Hall and Gilmore
Microtus oeconomus elymocetes Osgood

Microtus miurus paneaki, n. subsp.

Voles of the subgenus *Stenocranius*, apparently representing a new subspecies of *Microtus miurus*, occurred very commonly near Tolugak Lake, and also were collected at Umiat.

Type.—Skin and skull, young adult male, U. S. N. M. no. 290296; collected at Tolugak Lake (lat. 68° 24′ N., long. 152° 10′ W.), Brooks Range, Alaska, June 2, 1949, by Robert Rausch, original no. 21.

Range.—Type locality and vicinity; also taken at Umiat, on the Colville River.

Diagnosis.—Size medium. Five adult males measured: Total length 151 (140–170); tail 26 (23–30); hind foot 20 (19–21) mm. Five adult females measured: Total length 151 (146–155); tail 25 (22–29); hind foot 20 (20–21) mm. The males averaged 39.2 (32.3–46.1) grams in weight; the females (all pregnant) averaged 40.9 (32.2–51.2) grams. Dorsal ground color between Ochraceous-Tawny and Yellow-Ocher (capitalized terms are from Ridgway, *Color standards and color nomenclature*, 1912). Purest color on rump and flanks. Entire dorsal surface with heavy admixture of dark brown to black hairs, resulting in general grayish appearance. Ear patches ochraceous-buff, similar to rump. Sides tawny, shading into grayish on underparts and into ochraceous-buff on flanks. Some specimens more buffy on underparts. Dorsal surface of tail ochraceous-buff, with pale buff underneath. Feet gray. Skull long and narrow as typical of subgenus. Molar pattern as typical for species.

TABLE 1.—CRANIAL MEASUREMENTS (AVERAGE) OF VARIOUS SUBSPECIES OF CLETHRIONOMYS RUTILUS

Subspecies and locality	Number examined	Sex	Length of tooth row	Condylo-basal length	Zygo-matic width	Inter-orbital width	Mastoid width	Length of nasals
Clethrionomys r. rutilus:								
Lappmark	8	?	4.6	23.5	12.9	3.9	11.1	6.8
Siberia	9	♂	4.5	22.7	13.1	3.7	11.1	6.9
Clethrionomys r. jochelsoni:								
Northern Siberia	29	♀	4.6	22.7	12.9	3.7	11.1	6.7
Do	28	♂	4.6	22.7	12.8	3.7	11.0	6.6
Clethrionomys r. dawsoni:								
Tolugak Lake, Alaska	6	♀	5.1	23.4	13.0	3.9	11.1	7.2
Do	6	♂	5.1	23.6	13.0	4.0	11.4	7.3
Chignik and Charlie Creek, Alaska	14	♀	4.9	23.7	13.3	3.9	11.4	6.9
Do	10	♂	4.9	23.6	13.3	3.8	11.4	7.4

Comparisons.—Microtus miurus paneaki is differentiated from *M. miurus oreas* Osgood by more grayish color, strongly contrasting lateral streaks, and less over-all ochraceous coloring. The skull of *paneaki* averages larger than that of *oreas* and is slightly narrower cranially. The molar patterns are identical. From *M. miurus miurus* Osgood, *paneaki* differs in more grayish color, presence of a contrasting ochraceous flank streak, larger and more massive skull, longer and heavier rostrum, larger and more inflated bullae, and much heavier molars. Compared with the type specimen of *Microtus muriei* Nelson, the present form differs in much heavier and broader skull, wider zygomata, more inflated bullae, and more widely separated tooth rows. The molars are much heavier, and the interorbital depression is slighter in both immature and adult specimens. Two other obviously related species, *Microtus andersoni* Rand, 1945, and *M. cantator* Anderson, 1946, are both smaller than *M. miurus paneaki* and differ cranially and externally. Specimens of *andersoni* and *cantator* in the Collection of the National Museum of Canada have been examined by the writer.

More than a hundred voles of this species were collected near Tolugak Lake; they were very abundant in this vicinity during the summer of 1949. They were taken at altitudes from about 2,000 feet to above 3,000 feet. Their runways were numerous on the dry mountain slopes, often where vegetation was scarce.

This vole is named for my friend Paneak, one of the native Inland People, whose generous cooperation has contributed much to the success of the field work in the Brooks Range.

Lemmus trimucronatus alascensis Merriam

Although not so abundant as along the Arctic coast during 1949, the brown lemming was not uncommon at Tolugak Lake during September; about 15 specimens were taken during this time. Only a single specimen was captured there previously. An immature specimen was captured at Umiat, and the skull of an adult was taken from the stomach of a rough-legged hawk (*Buteo lagopus*), which was nesting on the bluffs of the Colville River near Umiat.

Dicrostonyx groenlandicus rubricatus (Richardson)

Only six specimens of this lemming were collected in the Brooks Mountains during 1949, and none was observed at Umiat. Additional observations would indicate that this species was generally uncommon during 1949 over the whole of the Arctic Slope. About 15 specimens were collected near Point Barrow, during a time when the brown lemming was exceedingly abundant.

REFERENCES

ANDERSON, R. M. *Mammals and birds of the Western Arctic District, Northwest Territories, Canada.* Canada's Western Northland: 97–122. 1937.

BAILEY, VERNON. *Revision of the American voles of the genus* Evotomys. Proc. Biol. Soc. Washington **11**: 113–138. 1897.

BOBRINSKOY, N., KUZNETZOV, B., AND KUZYAKIN, A. *Mammals of USSR.* Moscow, 368 pp. 1944. (In Russian.)

GILMORE, R. M. *Arctic mammalogy, in* "A Program of Desirable Scientific Investigations in Arctic North America." Arctic Inst. North America Bull. 1, pp. 35–43. 1946.

ORR, R. T. *A study of the* Clethrionomys dawsoni *group of red-backed mice.* Journ. Mammal. **26**: 67–74. 1945.

ZIMMERMANN, K. *Zur Kenntnis von* Microtus oeconomus (*Pallas*). Arch. Naturg., N. F., **11**: 174–197. 1942.